SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1912.

GENERAL PHYSICS.

772. *Flexure of Astronomical Meridian Circles.* **M. Hamy.** (Comptes Rendus, 154. pp. 549–555, Feb. 26, 1912.)—A new apparatus is described and illustrated having for its object the accurate determination of the flexure of meridian circles of precision. An optical system consisting of two objectives with a reflection prism between them is placed midway between the main object-glass and the micrometer threads, and so as not to interfere with the ordinary working of the instrument. In this way observations may be always made of the position of a fiducial mark engraved on the back surface of the main objective, and thus the presence of any flexure of the tube may be detected and its amount measured from time to time. C. P. B.

773. *Temperature Variations of Cast-iron Divided Circles.* **F. Göpel.** (Zeitschr, Instrumentenk. 32. pp. 33–43, Feb., 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Of recent years there has been a movement to employ cast-iron or steel for the circles of transit instruments for time and position determinations on account of its greater resistance to flexure than the bronze more usually employed. The divisions are generally on a band of silver inlaid near the outer rim of the circle, and it becomes of importance to determine accurately the variations of the scale divisions with different temperatures. The method used for determining these variations is described and illustrated, with tables showing actual results. C. P. B.

774. *The Testing of Plane Surfaces.* **P. E. Shaw.** (Roy. Soc., Proc. Ser. A. 86. pp. 227–234, Feb. 28, 1912.)—The usual plane surfaces, originated by the triplicate method, may have minute undulations too small to be detected by the "raddle" process. The author's apparatus is a very sensitive spherometer of special form with which the plate under test is surveyed. The zero reading of the spherometer is determined by comparing it with a similar spherometer with which the surface has been surveyed. Thus the author's method is really the triplicate method in which two of the surface plates are replaced by spherometers. Illustrations are given showing the apparatus, and actual tests on surface plates and commercial plate-glass are described. The mean error of a carefully scraped surface-plate is given as 2×10^{-6} in., and of commercial plate-glass from 3×10^{-5} in. to 3×10^{-4} in. H. S. R.

775. *Rifled Artillery.* **G. Greenhill.** (Engineer, 112. p. 505, Nov. 17, 1911.)—Points out that in a naval engagement, where the big guns would be fixed very quickly, the gun would become so hot that the rigidity modulus of the steel will be appreciably reduced, and consequently the muzzle, instead of twisting through an angle of 3′ or 4′, would probably twist through an angle nearly double. In this way the effective angle of departure of the rifling would fall below the theoretical angle, and so the shot become unsteady in air. This is advanced as an explanation of the wild shooting observed on a previous test with an uninterrupted fire of maximum rapidity. L. H. W.

776. *Optical Determination of Variation of Stress in a Thin Rectangular Plate subjected to Shear.* **E. G. Coker.** (Roy. Soc., Proc. Ser. A. 86. pp. 291–319, March 26, 1912.)—[See Abstract No. 296 (1911).] Describes tests on plates of xylonite subjected to pure shear applied to the long, parallel edges. The relative retardation R of the ordinary and extraordinary rays of a ray of plane-polarised light after transmission through a stressed plate is—

$$R = C\,(\widehat{rr} - \widehat{\theta\theta})\,T,$$

where $C =$ constant, $\widehat{rr}$ and $\widehat{\theta\theta}$ are the principal stresses at the point considered, and $T =$ thickness of plate. A pure shear is equivalent to a pull and a push, each equal to twice the shear and inclined at 45° to its direction. A "calibration member" is used to explore the specimen plate in shear, being cut from the same piece of xylonite. The calibration member is stressed in tension and interposed between plate and screen, being set along the direction of the push component of the shear. Thus when the tension is adjusted to twice the shear, the retardations neutralise each other and total extinction is obtained. The directions of the principal stresses were first mapped by using a pair of Nicol prisms with their principal planes at right angles. No light passes where the principal planes of the crossed prisms correspond with the principal planes of stress, which are thus mapped by dark bands. The principal stresses are inclined at 45° to the line of pull except at the ends. The disturbance of end distribution is about proportional to the breadth of the plate. The experiments show that the shear stress rises rapidly to a maximum at a distance from the ends rather less than the free breadth of the plate. For long plates the stress falls to a shallow minimum at the centre. The maximum and minimum become more pronounced with decrease of the ratio (length)/(breadth). When this ratio = about 2, the minimum disappears, there being one central maximum. The theoretical parabolic distribution of shear appears to be true only within narrow limits. For long plates the shear is approximately uniform except at the ends, where it falls rapidly. The distribution seems to be a simple function of the ratio (length)/(breadth). The apparatus is so devised and such preliminary optical tests are made as to justify the assumption that the shear is applied uniformly along the edges and centre of the plate. C. A. M. S.

777. *Brownian Movement of Particles due to very rapid Air Waves.* **S. Lifchitz.** (Comptes Rendus, 154. pp. 689–691, March 11, 1912.)—Further experiments are described to elucidate the phenomena which ensue in the neighbourhood of spark discharges [see Abstract No. 822 (1911)]. W. König's explanation [see Abstract No. 910 (1911)] that the phenomenon is the same as that described by Bjerknes is considered to throw light on the subject, but it cannot be accepted as a full explanation. The experiments show that the phenomenon is not due to the oscillating nature of the spark, but to the first shock due to the explosive wave travelling from it. A. R.

778. *Instability of Gaseous Jets.* **J. H. T. Roberts and E. Meigh.** (Phil. Mag. 23. pp. 368–375, March, 1912.)—Experiments were undertaken to see how the phenomena of flow would be modified as shorter and shorter tubes were used, ultimately approximating to holes in infinitely thin plates. Weighted gas-bags were used for driving the gas through the various orifices used. It appears that the instability of a jet depends upon the vorticity at its surface. Any tubularity of the orifice from which the jet issues communicates stratified formation to the jet, and thus, in general, lowers the pitch of the sonorous disturbances to which it is sensitive, and diminishes the sensitiveness. The flaring-pressures of the flames from holes in thin plates are very much higher than those of the flames from tubes; on this account the flames from the former orifices are long and stiff. The transition of velocity at the surface of such jets is sudden, the pitch of the sonorous disturbances to which the jets are sensitive is very high, and the sensitiveness is much greater than that of the jets from other orifices; in some cases the sensitiveness of a simple flame jet would approximate to that of the ear itself. The flaring appears to depend, for a certain range of diameters of orifices, almost simply upon the linear rate of flow at the orifice. For diameters above this range flaring occurs at much lower pressures. The high temperature in ignited jets leads to increased viscosity, and this tends to explain the higher pressures then admissible. For a given pressure and orifice the rate of flow is greater for an unignited than for an ignited jet. A. W.

779. *Hydrodynamic Fields of Force.* **V. Bjerknes.** (Phys. Zeitschr. 13. pp. 21–28, Jan. 1, 1912.)—Discusses two electro-hydrodynamical analogies. In the first, specific momentum is identified with field intensity and velocity with induction; while in the second the identifications are reversed, velocity representing field intensity. In the second analogy the liquid is made to obey the relations $\mathrm{V} = \rho v$; $\mathrm{div V} = -\partial\rho/\partial t$; and curl $v = 0$, when v is velocity, V specific momentum, and ρ the density. The force exerted by the liquid is then $-v\,\mathrm{div V} + \frac{1}{2}v^2\nabla\rho$. This analogy, like the first one, may be considerably extended, as by writing curl $v = c$, when c is a vector independent of time. This gives a field having vortices stationary in space. A special case of this is represented by the system imagined by Euler and investigated by Kelvin, in which the ends of long tubes carrying a stream, figure as centres of emergent and immergent radial currents and replace the centres of constant condensation and rarefaction of matter. The author replies to Witte's criticisms [Abstract No. 2122 (1909)] in a footnote. E. E. F.

780. *Influence of Light upon the Damping of Oscillations.* **A. Naccari.** (Accad. Sci. Torino, Atti, 47. 2. pp. 55–64, 1911–1912.)—The author has considered and repeated the early experiments of S. H. Christie (Phil. Trans. 1826 III., pp. 219, and 1828 I., p. 379, "On Magnetic Influence in the Solar Rays") and the later work of Baumgartner, who attributed the effects observed by Christie to convection currents and other movements produced by the heat of the solar rays, on the air of the receptacle in which the needle

oscillates. The author made experiments on the oscillations of metallic needles, both magnetised and unmagnetised, in closed and open vessels, and also discs of glass, &c., suspended in pairs by silk threads. The rates of vibration, amplitudes, and the damping produced in the dark, in diffuse daylight and bright sunshine, were noted carefully. Magnetised steel bars, brass cylinders, and aluminium discs suspended by silver threads were also employed, and their oscillations in closed and open vessels observed. Short tables are given showing the values of the logarithmic decrement deduced from series of experiments of 20 oscillations at each temperature and the increased effect due to sunlight over that obtained in the dark. The light was diluted in various ways by the interposition of screens passing through a small thickness of water, &c. Contrary to Christie's statement it was found that the effect was less pronounced on magnetised steel than on non-magnetic brass. Card and glass discs, plain and blackened, were also employed. In the latter case the damping was notably increased by exposure to the solar rays. The coefficient of viscosity obtained from experiments with two brass discs, resulting from three series of experiments came out as $\eta = 0{\cdot}000197$ at 20° with very little light, and at 23° when the solar rays fell upon the cylinder containing the discs it rose to a value of $\eta = 0{\cdot}000413$. A similar, though smaller, increase was obtained as the result of exposure to artificial light. All the experiments showed clearly that the effects are due to the *heating* produced by the radiant energy. Even when the experiments were made in diffuse daylight there was a notable increase in the effects over those in darkness of from 9 to 14 per cent. The kinetic theory of gases gives a simple explanation of all these phenomena. The internal friction (viscosity) of the air is due to the difference of velocity of the molecules in adjoining strata of air. For a solid body moving (oscillating) in air, if we suppose that a layer of air adheres to it and shares in its motion, the decrease of amplitude is a necessary consequence. The author gives a formula for the increase of viscosity with temperature, $\eta = \eta_0(1 + 0{\cdot}0025t)$, η_0 being the value at 0°, and η its value at any temperature t. When radiation falls upon an oscillating disc much of its energy serves to increase the velocity of the molecules in the "air-skin" adhering to the disc, and thus to increase the damping effect. Part of the radiation heats the air immediately adjoining, and this augments the same action. F. W. H.

781. *Pendent Drops.* **A. Ferguson.** (Phil. Mag. 23. pp. 417–430, March, 1912.)—In papers by A. M. Worthington on pendent drops it has been shown how the surface tension of a fluid may be evaluated by tracing on paper the magnified image of a pendent drop of the fluid. If this outline be cut out of paper of uniform texture the volume, position of the *c.g.*, and the area of a meridional section of any given portion of the drop can be estimated, and from a knowledge of these quantities the surface tension may be calculated. The present author considered that the result might be obtained in a more convenient manner by photographing the pendent drop in such a way that the photograph should not only show the contour of the drop, but should also enable the distance from the *free* surface of the liquid to any point of the drop to be measured. Some photographs are given, and also calculations. The method is being further worked in detail. E. H. B.

782. *Theory of Matter.* **G. Mie.** (Ann. d. Physik, 37. 3. pp. 511–534, March 8, 1912.)—The fundamental assumption of this theory of matter is that electric and magnetic fields penetrate into the *interior of electrons.* Further,

the electrons are not conceived as foreign bodies intruded into the ether, but they are regarded as only the places where the ether has that *special state* denoted by the term *electric charge.* Two more assumptions are then found necessary. The first is, that the *relativity principle* has a *general validity.* The second is, that the hitherto recognised states of the ether (namely, electric field, magnetic field, electric charge, convection current) suffice to describe all the phenomena of the material world. The formal mathematical treatment then follows and uses the four-dimensional vector analysis. E. H. B.

783. *The Ether.* **P. G. Nutting.** (Washington Acad. Sci., Journ. 2. pp. 195–202, April 19, 1912. Paper read before the Physics Assoc. of the Bureau of Standards, Feb. 5, 1912.)—What we wish to know about the ether is whether it exists or not, what are its nature and properties, and what are its relations to electricity, gravitation, radiation, induction, and chemical affinity. As to the *existence* of the ether, the author reviews the evidence under attraction, radiation, and electromagnetic field, and concludes in favour of an ether of an electromagnetic nature. As to the *nature* of the ether (beyond its electromagnetic character) it is suggested that it may be also mechanical, after all, but in *four* dimensions; or it may be of non-mechanical or unknown nature but of three dimensions. To the latter view the author inclines.

E. H. B.

784. *Mass of a Moving Body.* **R. C. Tolman.** (Phil. Mag. 23. pp. 375–380, March, 1912.)—An acceptance of the Einstein theory of relativity necessitates a revision of the Newtonian system of mechanics. In making such a revision it is desirable to retain as many as possible of the simpler principles of Newtonian mechanics. From the theory of relativity Einstein has calculated both the transverse and the longitudinal accelerations experienced by a charged body moving in an electromagnetic field. On the basis of these calculations it has been usual to use corresponding transverse and longitudinal masses which are respectively $m_0/\sqrt{1-u^2/c^2}$ and $m_0/(1-u^2/c^2)^{3/2}$, where m_0 is the mass at rest and c is the speed of light. The present author objects to the use of *two masses* for a given body at a given speed, and prefers to use the former of the above values as *the mass* of the moving body. It is then shown that this mass will serve as that for use in a longitudinal collision. [See Abstracts Nos. 1488 (1909) and 357 (1912).] E. H. B.

785. *Theory of Gravitation.* **M. Abraham.** (Accad. Lincei, Atti, 20. pp. 678–682, Dec. 17, 1911. Phys. Zeitschr. 13. pp. 1–4, Jan. 1, 1912.)—A theory of gravitation is developed which satisfies the principle of relativity and results in Einstein's relation between the velocity of light and the gravitational potential. Gravitation is propagated with the speed of light but consists of longitudinal instead of transverse waves. One of the results obtained is that at any two points the difference in half the squares of the speed of light equals the difference in the gravitational potential. Here is an imperfect analogy with the old emission theory of light. "Particles" of light subject to gravitation would undergo an increase in kinetic energy equivalent to the *decrease* of potential energy. According to the author's results the increase in kinetic energy equals the simultaneous *increase* in potential energy. The curvature of the light-beam in the gravitational field is, however, the same in both cases. If two material points approach under the action of gravitational force the increase of their aggregate kinetic energy equals half the decrease of their aggregate potential energy. The other half remains in the gravitational field, and so disposes of Maxwell's difficulty with regard to a negative energy-density. The flux of energy in the gravitational field is dealt with in detail. E. E. F.

786. *Instantaneous Propagation of Gravitational Force.* **J. Boussinesq.** (Comptes Rendus, 154. pp. 737-742, March 18, 1912.)—Astronomically, the rate of propagation of gravitational attraction is indistinguishable from an infinite speed. This fact, with its mechanical consequences as regards equality of action and reaction, the conservation of momentum and of energy, is difficult to conceive on the hypothesis of a propagating medium. The author prefers to regard the mutual action of two gravitating bodies as due to the presence of each throughout space. This "presence" is a kind of attenuated existence, the real or full existence of each material particle being limited to a geometrical point. The atoms, or their smaller constituents, thus become again mere centres of force as proposed by Boscovich. This is the tendency of modern physical thought. The "field of force" due to each particle moves with it, and extends as far as the force is perceptible. There is, therefore, no need for propagation, and no lapse of time required to bring the force at any distance fully into play. The author points out the perfect continuity thus introduced into dynamics, and the fuller play accorded to geometrical and analytical conceptions, which are still far ahead of the best methods of observation. E. E. F.

787. *Gravity Determinations at Sea.* **L. A. Bauer.** (Amer. Journ. Sci. 33. pp. 245-248, March, 1912.)—Bauer replies to some criticisms which Hecker has made on a former paper [see Abstract No. 812 (1911)]. He states that the boiling-point observations made on the *Carnegie* were not made for the purpose of gravity determinations, but merely for controlling the correctness of the aneroids. In particular, he points out again the necessity for frequent checks of the thermometer zeros. A. D. R.

788. *Gravity Anomalies and Geologic Formation in United States.* **W. Bowie.** (Amer. Journ. Sci. 33. pp. 237-240, March, 1912.)—A discussion is given of a further set of studies which confirm the conclusions arrived at in a former investigation of the effect of topography and isostatic compensation on the intensity of gravity. The anomaly considered is the difference between the observed gravity and the theoretical gravity for the latitude of the station, corrected for elevation, &c. The computations are based upon the theory of complete compensation of the separate topographic features, this being uniformly distributed at a depth of 114 km. On the whole the gravity anomalies in the United States are small, and there is, apparently, no connection between the size and sign of the anomaly and the character of the topography. There appears to be a relation between the surface geologic formation and the anomalies. C. P. B.

789. *The Barometer Period of Three and a half Years.* **C. Braak.** (Meteorolog. Zeitschr. 29. pp. 1-7, Jan., 1912.)—The monthly mean values of pressure at Port Darwin in the north of Australia from 1878 to 1911 show that there are well-marked periods in the pressure variations of about 3½ years in length. The changes are frequently repeated with great regularity, and then disappear for a time; only to be renewed again. Thus there are well-marked maxima in 1881, 1885, 1888, and 1891, but the next maximum does not occur until the end of 1896, and it is followed by others in 1900,

1902, and 1905, since when there has been no distinct maximum. The whole of the region comprising India, the Malay Archipelago, and Australia shows similar changes, and associated with them occur temperature variations with maxima about midway between the maxima of pressure. It has been supposed that variations in solar energy account for the variations of temperature, which in turn produce the variations of pressure. From an examination of the curves, however, it appears that a pressure wave resembles the temperature wave which follows it rather than that which precedes it, and the suggestion arises that the changes of pressure are the cause of the changes of temperature, and not conversely. The process may be as follows: Through some cause pressure becomes high over the region. The wind thereupon becomes feebler and the air takes less part in the general circulation than usual. Diminished air circulation means diminished oceanic circulation; consequently air and water become relatively stagnant, and are hence subject to the continued action of the tropical sun, which gradually increases the temperature, and finally produces a maximum in the temperature curve. The increase goes on until the effect of the high temperature on the pressure is to diminish it and eventually to replace it with a generally low pressure. Conditions are now reversed, for low pressure means increased wind velocity, and a considerable interchange of air and water between equatorial and temperate regions, resulting in a lowering of temperature in the equatorial region. Ultimately this temperature-change increases the pressure, until high pressure is once more restored and the cycle begins again. The pressure and temperature changes are thus ascribed to terrestrial, and not to solar influences. R. C.

790. *Secondary Undulations of Tides caused by Cyclonic Storms.* **T. Terada.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 13. pp. 196–201. Feb., 1912.)—The paper deals mainly with the secondary undulations of tides produced by a well-defined cyclonic storm which passed up the east coast of Japan on July 24–26, 1910. The time of commencement of the conspicuous undulations is traced at different stations along the coast, and is found to be from 4 to 10 hours in advance of the arrival of the centre of the cyclone, and to be closely associated with the arrival of one particular isobar (that of 750 mm.). This connection with a definite isobar was found also to hold for another storm which was investigated. In summarising the results the author is led to the conclusion that from the centre of a cyclone a train of long-period waves is propagated in all directions, and that each wave dies away very rapidly and becomes inconspicuous when it has travelled a distance of only several hundred km. J. S. Di.

791. *Velocity of the Earthquake Wave of April* 10, 1911. **G. Agamennone.** (Accad. Lincei, Atti, 21. pp. 201–207, Feb. 4, 1912.)—In a previous note [see Abstract No. 1092 (1911)] the author has assigned the position of the epicentre of this earthquake to the NW. of the volcano Laziale, 6 km. from Rocca di Papa and 18 from Rome, basing his estimates on the distribution of intensity over the affected area and the times of observation of the several shocks. Two principal velocities V_1, that of the seismic wave which produced the first traces indicated by the seismograms, and the second V_2, the "reinforcement," were determined from the records of observations made at stations up to a distance of 500 km. from the epicentre; the former (V_1) turned out 6 km. per sec., the latter (V_2) had one-half this value, 3 km. per sec. Though for the former velocity the author has adopted the least

speed that could reasonably be accepted as satisfying the observations, yet since this is much greater than is met with in such cases, he goes on to justify his result, and also points out that speeds not much lower have been accepted by others. He gives a table of a number of places at distances from 6 km. (Rocca di Papa) to 510 km. (Agram) where the shocks were recorded, with the times of commencement, and for a number of these the intervals to the second phase, to maximum and to end of the earthquake. A further table gives some additional particulars including velocities, &c. From this latter he concludes that the superficial velocity of the waves at the start of the seismograms was 6–8 km.; that of those forming the beginning of the second phases, 3–4½ km.; and that of those at the *maximum*, 2–3 km. In conclusion, he quotes the remarks of G. Negri, who concludes from the comparison of the Japanese formulæ deduced from the numerous observations of earthquakes in Japan, with those obtained from observations of Italian earthquakes, that the velocity of the preliminary shocks in the former country remains pretty constant (for a distance of 1000 km.) at about 6 km. per sec., whilst the Italian earthquakes have a *smaller* speed, about 5 km. per sec. But as it would seem from the author's own measures that here the Japanese speeds are *surpassed* by the Italian, it will be seen how necessary it is to be cautious in attributing importance to small divergencies in the results of such difficult researches. F. W. H.

792. *Fall of a Meteorite.* **E. Thomson.** (Amer. Acad., Proc. 47. No. 19. pp. 721–733, March, 1912.)—Description of the peculiar crater Coon Butte in Arizona, which is supposed to be the result of the fall of a large meteorite. The outer slopes of the hill are yellowish in colour, contrasting strongly with the reddish soil of the general district. The height above the surrounding desert is about 150 ft., but inside the crater is some 570 ft. deep, its floor being some 400 ft. below the desert level. The diam. of the crater is about three-quarters of a mile. Masses of meteoric iron have been found scattered in all directions around the formation. The evidence is taken as more favourable to the crater being meteoric in origin rather than volcanic. C. P. B.

793. *Pressure of Igneous Emanation.* **B. Stevens.** (Amer. Inst. Mining Engin., Bull. 64. pp. 411–427, April, 1912.)—Assuming that the chief cause of intrusion of foreign minerals into various strata is the pressure developed by superheated steam or water at abyssmal depths in the earth's crust, a number of actual formations are figured and described to illustrate the theory. The study of this aspect of the problem may have important bearings on the prospecting of mineral deposits. C. P. B.

794. *Self-luminous Night Haze.* **E. E. Barnard.** (Amer. Phil. Soc., Proc. 50. pp. 246–253, May–June, 1911.)—In a previous paper on the occurrence of auroræ [Abstract No. 669 (1910)] attention was drawn to the frequent luminous condition of the night sky, a feature dependent on a more extensive luminosity than could be due to the well-known "night clouds." This is now further described, with a series of observations made since 1910, giving details of long wispy streaks of luminous matter visible sometimes over large areas of the sky. C. P. B.

795. *Best Value of Solar Constant.* **C. G. Abbot** and **F. E. Fowle, Jr.** (Astrophys. Journ. 35. pp. 92–100, March, 1912.)—The work of the authors has recently been criticised by F. W. Very [Abstract No. 282 (1912)], who

stated that they had relinquished the reformed methods instituted by Langley and reverted to those of Pouillet [Abstract No. 826 (1911)]. They show now, however, that their later results are careful developments of work at various altitudes and degrees of atmospheric purity, and that even at the best stations the readings never exceeded 1·75 cals. per cm.^{2} per min. The corrected value from all observations is given as 1·98 cals. per cm.^{2} per min. Very's contention appears to be based on estimates of the probable values of reflection and emission of the earth, moon, and Mars, and on the temperature of the two latter, whereas these are by no means known quantities. C. P. B.

796. *Solar Eclipse of April* 17, 1912. **W. J. S. Lockyer.** (Nature, 89. pp. 219–221, May 2, 1912.)—Description of observations of the eclipse as seen from the neighbourhood of Paris, near Chavernay, the site being selected from an examination of a large chart published in *L'Astronomie.* On this the various tracks predicted by the various ephemerides are indicated, and the one chosen was that of the American ephemeris. A sketch is given showing the appearance of the eclipsed sun at maximum phase. Several prominences were recorded. **M. Štefánik.** (Comptes Rendus, 154. pp. 565–567, Feb. 26, 1912.)—Photographs of the corona were obtained with long and short exposures. At the north pole scarcely any coronal structure was visible; at the south pole there were numerous polar plumes. In lower latitudes the coronal streamers were longer, and formed the wind-vane structure characteristic of minimum solar activity. With the spectrograph a record of the coronal spectrum was obtained, showing the chief corona line as a degraded band gradually diminishing in intensity away from the moon's limb. C. P. B.

797. *Wave-length of Sodium Lines in Solar Spectrum.* **A. Perot.** (Comptes Rendus, 154. pp. 826–829, Feb. 5, 1912.)—By examining the wave-length of the sodium line D_1 at various points on the sun's disc it is proved that there is a regular variation as the points selected vary from the edge to the centre of the sun. A curve is given showing the degree of variation, which is similar to that shown by magnesium [Abstracts Nos. 1099, 1439 (1911)], and indicates a velocity of descent of the vapours corresponding to about 1·37 km. per sec. C. P. B.

798. *Formation of Lunar Craters.* **H. Bénard.** (Comptes Rendus, 154. pp. 260–263, Jan. 29, 1912.)—Experiments with the slow solidification of liquids agitated in certain definite ways have shown the possibility of formation of structures resembling the craters on the surface of the moon. The formations are due to the cells of the pattern produced by the interfering vortices, the general division of the mass being polygonal. This theory would appear to give a satisfactory explanation of the circles with central peaks, the stepped ramparts of certain craters, and the angular (hexagonal, &c.) formation of Ptolemy, Alphonsus, Albategnius, Rhœtius, Janssen, &c. C. P. B.

799. *Sun's Mass and Planetary Motions.* **T. J. J. See.** (Amer. Phil. Soc., Proc. 50. pp. 269–273, May–June, 1911.)—Assuming that the sun is gaining mass by the fall of cosmical dust, and losing mass by the continual repulsion of finely-divided matter, an investigation is made of the secular effects of the increase of the solar mass upon the mean motions, major axes, and eccentricities of the orbits of the planets. C. P. B.

800. *Formation of Lunar Circles.* **E. Belot.** (Comptes Rendus, 154. pp. 638–640, March 4, 1912.)—Experiments are described in which it was

sought to obtain formations similar to the circles characteristic of the lunar surface. Taking water at 60° C., melted paraffin poured on the surface forms into a roughly polygonal structure on congealing. Cold water is then poured on the highest parts of the reseau, and this produces a depression. The effect of subsequent volcanic action is imitated by having the first water alkaline, and the second acid; wherever this pierces the solidified crust of the circle gas is evolved and remodels the surface features. Reproductions of photographs of various stages of the experiments show very remarkable resemblance to the lunar formations. C. P. B.

801. *Physical Conditions on Mars.* **S. Arrhénius.** (Journ. de Physique, 2. Ser. 5. pp. 81–97, Feb., 1912.)—The physical features of the surface of Mars are discussed from the standpoint of finding terrestrial analogies to their peculiar forms. Illustrations are given of various structures on the earth which closely resemble the Martian "canals," notably the network of geotectonic lines occurring in Calabria and Sicily. A comparison is also given of the recent investigations of the probable temperature of the planet. C. P. B.

802. *Colour of Saturn.* **H. E. Lau.** (Astronom. Nachr. No. 4566. Nature, 89. p. 199, April 25, 1912. Abstract.)—Description of observations of the planet with the 10-in. refractor of the Urania Observatory during 1908–1910. Colour of south pole bluish-green changing to brownish-green at a little distance from polar region. Differences of colour between the different parts of the rings are recorded. C. P. B.

803. *Relations between Planets and Comets.* **T. J. J. See.** (Amer. Phil. Soc., Proc. 50. pp. 266–268, May–June, 1911.)—Taking Babinet's criterion, it may be shown that none of the planets have been thrown off from the sun, as was formerly outlined by Laplace, and that the roundness of the orbits is probably due to the secular action of a resisting medium. Possibly also the orbits were primarily greatly eccentric, but have been reduced as the masses became greater by accretion of colliding matter. As the orbit of Neptune is very nearly circular, it is suggested that this gives reason for expecting other bodies beyond it, in the region occupied by the known cometary orbits of great eccentricity. C. P. B.

804. *Spectrum of Comet Brooks* (1911*c*) **N. Lockyer.** (Roy. Soc., Proc. Ser. A. 86. pp. 258–262, March 26, 1912.)—Photographs of the spectrum of the comet have been obtained by the Solar Physics Observatory Staff with a quartz-calcite prismatic camera, showing the usual cometary bands at λ4737 and λ3883, and on some plates three lines in the ultra-violet near λλ310, 316, and 337. An investigation of laboratory spectra was made to determine, if possible, the origin of these lines, but was unsuccessful. A plate is given showing the spectrum of the comet on Sept. 30 and Oct. 31, 1911, and a comparison of the spectrum with that of Comet Daniel obtained by Campbell at the Lick Observatory in 1907. C. P. B.

805. *Spectrum of Comet Morehouse.* **A. Fowler.** (Astrophys. Journ. 35. pp. 85–91, March, 1912.)—In previous papers the special bands of the spectrum of Comet Morehouse were ascribed to low-pressure CO [Abstracts Nos. 367, 1087 (1910); 1663 (1911).] Pluvinel and Baldet drew attention to the greater number of doublets in their comet spectrum compared with the laboratory spectrum of CO, but this is shown to be simply due to their

comparative weakness and lower refrangibility. One set of Pluvinel's bands is suggested to be an independent series, and a formula is given with computed and observed wave-lengths strongly supporting this view; further discussion is also given of details of the various doublets and their inter-relationship. Photographic comparisons accompany the paper, showing the spectrum of the comet obtained by Curtis at Santiago, Chili, and the laboratory series of doublets placed in juxtaposition for corresponding bands. Out of the five or six recent comets which have shown the low-pressure CO spectrum, it was only in Comet Morehouse that the bands were bright in the head as well as in the tail. The bands in question may therefore be regarded as especially characteristic of the tails of comets. C. P. B.

806. *Formation of Rings in Laplace Nebula.* **E. Belot.** (Comptes Rendus, 154. pp. 752–754, March 18, 1912.)—In subsequent discussions of Laplace's theory of the primordial nebula, Roche attempted to justify the formation of ring structures, and Poincaré, in his *Leçons sur les hyphothèses cosmogoniques*, has raised several objections to the idea. An examination is made of the formulæ for equipotential surface distribution in a homogenous nebulous mass, introducing various conditions, results in the suggestion that there may be an epoch when repulsive forces are more in evidence than those of attraction, and this must be considered in the problem of ring-formation. C. P. B.

807. *Spectrum of Ring Nebula in Lyra.* **M. Wolf.** (Nature, 89. p. 70, March 21, 1912. Abstract of paper read before the Heidelberg Academy).—Photographs of the spectrum of the ring nebula in Lyra have revealed the fact that different portions have characteristic spectra. The ordinary bright portion of the ring material shows the ordinary nebula spectrum, while throughout the central, apparently dark space there is evidence of the presence of some substance which radiates light of λ4686. Another line, λ3729, is of special behaviour in that it shows intensification on the outer borders of the bright ring. C. P. B.

808. *Constitution of Ring Nebula in Lyra.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 72. pp. 176–177, Jan., 1912.)—In the theoretical analysis of the spectrum of nebulium it was shown that all the nebula lines except two could be accounted for, the exceptional lines being λ4685·7 and λ3729·0. In photographs of the spectrum of the ring nebula recently obtained by M. Wolf at Heidelberg [see preceding Abstract] the differences in composition of various regions of the nebulous matter are very clearly shown, and it is of great interest to find that the lines 4685·7 and 3729 are distinctly localised in the nebula. Thus the central dark space of the ring appears to emit the radiation 4685·7, which is, however, absent from the bright ring itself. The radiation 3729 proceeds chiefly from the outer edge of the bright ring. All the other radiations have their max. brightness near the max. brightness of the ring. C. P. B.

809. *Absorption of Light in Space.* **F. G. Brown.** (Roy. Astronom. Soc., M.N. 72. pp. 195–202, Jan., 1912.)—An attempt is made to estimate the absorption of light in space by a discussion of the brightness of the known nebulæ. It is assumed that, as the nebulæ have measurable diameters, therefore those objects with a small apparent diameter must be, on the average, more distant than the larger objects, in spite of the fact that their real

diameters vary greatly. Using Dreyer's New General Catalogue the various nebulæ were classified according to their estimated size and brightness, and keeping the objects separate for each hour of Right Ascension. The results of the analysis are plotted in zone diagrams, and it is suggested that the variations shown are indicative of a physical law of distribution and not simply accidental. To test whether the variations may be due to cosmical absorption, star counts have been made in all the zones examined, and the evidence appears to be in favour of there being an increased absorption in certain regions. C. P. B.

810. *Distribution of the Asteroids.* **P. Lowell.** (Phil. Mag. 23. pp. 337–351, March, 1912.)—On examining the distribution of the asteroids composing the zone of minor planets circling between the orbits of Mars and Jupiter, certain well-defined gaps become apparent, as first pointed out by Kirkwood. He showed that these gaps occurred at just the points where a minor planet would have a period commensurable with that of Jupiter, and this suggested that the perturbing action of the large planet might be the cause of the gap. In the present paper the author gives an exhaustive analysis of the possibility of any libration movement, and shows that this is absent, thus supporting the idea that the gaps are permanent features of the asteroid zone. C. P. B.

811. *Star Systems and Milky Way.* **J. C. Kapteyn.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 909–911, March 28, 1912.)—In a previous paper [Abstract No. 461 (1912)] a suggestion was made concerning an apparent relation between the Milky Way and the now well-known star streams, in that the motion relatively to the centre of gravity of the whole system is very nearly parallel to the plane of the Milky Way. This is true separately of stars of the B, A and G types. Further examination has shown that this feature is also applicable to the motion of all the rich systems for which sufficient data are available. C. P. B.

812. *Spectrum and Orbit of β Scorpii.* **Daniel** and **Schlesinger.** (Allegheny Observatory Publication, 2. No. 14. Nature, 89. p. 121, April 4, 1912. Abstract.)—The authors discuss the reductions of 73 plates of the spectrum of β Scorpii. These confirm Slipher's observation that the H and K lines do not share the velocities exhibited by the other lines. Other features of interest are the great eccentricity of the orbit and the comparatively large masses of the components. C. P. B.

813. *Nova Geminorum.* **M. Hamy** and **Millochau.** (Comptes Rendus, 154. pp. 793–795, March 25, 1912.)—The spectrum of the new star in Geminorum has been observed with various instruments at the Paris Observatory, including slit spectrographs and prismatic cameras. Five plates were obtained between March 20 and 22 with exposures varying from 30 min. to 3 hours. The spectra show the presence of strong continuous spectrum, with brilliant isolated lines and strong absorption bands. Of the luminous radiation the most conspicuous is that of hydrogen, the characteristic lines being about 20 Å. units wide. H_β is sharply divided into three equal portions by dark lines, and a similar structure is shown in the other hydrogen line H_γ. The absorption lines lie always to the violet side of the bright lines, and if due to motion would indicate a velocity of approach of 1800 km. per sec. **F. E. Baxandall, W. E. Rolston.** (Nature, 89. pp. 200–201, April 25, 1912.)—A number of spectra have been taken with prismatic camera

at the Madrid Observatory under the direction of F. Iñiguez, and positives supplied for enabling others workers to assist in the interpretation of the peculiar spectrum involved. F. E. Baxandall discusses the spectra obtained at Madrid on March 19 and 22, 1912, comparing it with the spectrum of Nova Persei on March 8, 1901. In the main the spectra of the two Novæ are very similar. The complex arrangement of bright bands is shown to be very closely accounted for by assuming them to be enhanced lines of iron, and in the region less refrangible than H_β there are four bands so isolated that their close coincidence with four well-marked iron enhanced lines leaves little doubt that this is the correct interpretation of the Nova spectrum. A direct comparison with the spectrum of α Cygni, a star whose spectrum is the most typically representative of enhanced lines, gives further confirmation, the isolated strong lines of α Cygni falling exactly on the middle of the broad Nova lines. C. P. B.

814. *Spectra and Colours of Red Stars.* **J. A. Parkhurst.** (Astrophys. Journ. 35. pp. 125–138, March, 1912.)—Since 1906 a systematic investigation has been in progress for determining the relationship between the spectra and colours of stars. It has been found that the groups of the Harvard spectral classes are certainly in a simple relation to the colour indices of the stars considered. [See Abstract No. 355 (1910).] C. P. B.

815. *Parallax of Nova Lacertæ,* 1910. **F. Slocum.** (Astrophys. Journ. 35. pp. 134–138, March, 1912.)—Plates for the determination of the parallax of this Nova have been obtained with the 40-in. Yerkes refractor. The resulting value is $\pi = +0{\cdot}013'' \pm 0{\cdot}014''$. If this value be correct it means that the outburst of Nova Lacertæ seen in 1910 really occurred in the year 1730. C. P. B.

816. *Frequency Law of Stellar Motions.* **A. S. Eddington.** (Roy. Astronom. Soc., M.N. 72. pp. 368–386, March, 1912.).—The mathematical theory of the problem of determining the law of stellar motions is given in detail, and by applying it to the material contained in Boss's Preliminary General Catalogue (excluding the stars of the Orion type) between certain limits of R.A. and Decl., 1129 stars in all, a result is obtained favouring the idea that the stellar motions are of the two-drift order, as opposed to the ellipsoidal theory. The principal results are given in graphical form in a diagram showing the actual distribution of the linear motions. C. P. B.

817. *Photographic Registration of Star Scintillation.* **G. A. Tikhoff.** (Comptes Rendus, 154. pp. 329–331, Feb. 5, 1912.)—Photographs of the spectra of stars are obtained with a prismatic camera, the photographic plate being moved during the exposure in a direction perpendicular to the length of the spectra. By means of the changes in the spectrum lines it is hoped to measure the variations of intensity of the different rays. An interesting arrangement is then to place a positive made from such a negative in a spectroscope arranged as a Newton colour box, when the varying scintillation colours may be shown as they occurred while being photographed. C. P. B.

818. *Theodolite with Electromagnetically actuated Fine Adjustment.* **W. Hoffmann.** (Zeitschr. Instrumentenk. 32. pp. 57–59, Feb., 1912.)

819. *Wireless Determination of Longitude.* **Bourgeois.** (Comptes Rendus, 154. pp. 181–184, Jan. 22, 1912.)—The difference of longitude between Paris

and Bizerta has been recently determined by means of the exchange of wireless signals. Local time was determined by the prism astrolabe. The final results indicate a probable error of ± 0·01 sec. C. P. B.

820. *Report of the National Physical Laboratory for* 1911. **R. T. Glazebrook.** (Pp. 3–103, 1912. Engineering, 93. pp. 392–394, March 22, and pp. 410–413, March 29, 1912. Abstract.)

821. *Condensation of Solar Nebula.* **du Ligondès.** (Comptes Rendus, 154. pp. 493–494, Feb. 19, 1912.)—An analysis is made of the condensation phenomenon of the supposed primordial nebula postulated by Laplace, which must on that theory have originally extended beyond the orbit of Neptune. A table is then given showing the moment of rotation of the nebulous mass at the epoch of formation of each of the successive planets. C. P. B.

822. *Reversible Pendulum.* II. **J. C. Shedd, J. A. Birchby,** and **W. N. Birchby.** (Phys. Rev. 34. pp. 110–124, Feb., 1912.)—In a previous part theoretical relations were derived and discussed, and the present paper deals with experimental verifications. A third part is promised treating of best values and Kater's classic experiments. [See Abstract No. 2012 (1907).] E. H. B.

823. *Viscosity in the Motion of Flexible Membranes.* **L. Roy.** (Comptes Rendus, 153. pp. 1132–1134, Dec. 4, 1911, and 154. pp. 109–112, Jan. 15, 1912.)—Mathematical.

824. *Molecular Attraction and the Properties of Liquids.* **R. D. Kleeman.** (Phil. Mag. 22. pp. 566–586, Oct., 1911.)

825. *Elements of a Kinetic Theory of Crystals.* **J. Beckenkamp.** (Soc. franç. de Minéralogie, Bull. 34. [pp. 1–55] Dec., 1911.)

826. *Motions of Continuous Media.* **K. Żorawski.** (Acad. Sci. Cracovie, Bull. 3a. pp. 269–272, March, and 4a. pp. 273–292, April, 1912.)—Deals mathematically with certain properties of the motions of continuous media, and is in continuation of previous work on the same subject. [See Abstract No. 850 (1911).] E. H. B.

827. *Daily and Yearly Variations in Duration of Sunshine at Trieste.* **E. A. Kielhauser.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 837–849, June, 1911.)

828. *Non-periodic Barometer Fluctuations.* **W. Köppen.** (Meteorolog. Zeitschr. 29. pp. 97–103, March, 1912.)—The author proposes to examine these fluctuations (periods greater than 1 day and not over 30 days); the present paper is only a preliminary discussion of the question. L. H. W.

829. *Eccentricities and Inclinations of Planetary Orbits.* **R. T. A. Innes.** (Roy. Soc. S. Africa, Trans. 2. 3. pp. 287–291, 1912.)—The paper contains the result of an analysis of the relations existing between the eccentricities and inclinations of the orbits of Jupiter and Saturn. C. P. B.

830. *Mean Distances of Planets.* **R. T. A. Innes.** (Journ. of Science, South Africa, pp. 1–6, Feb., 1912.)—Details an analysis of the data for determining planetary mean distances, with a remark as to the necessity for a more precise definition of the factor, seeing that some of the standard ephemerides are not in agreement as to the values given. C. P. B.

LIGHT.

831. *Grating Spectroscope.* **W. Voigt and H. M. Hansen.** (Phys. Zeitschr. 13. pp. 217–224, March 15, 1912.)—Describes the new grating spectroscope of the Göttingen Institute, and observations with it on magnetic double refraction in the neighbourhood of absorption lines. The Littrow principle of auto-collimation is adopted in the spectroscope, a plane reflection grating being used. Diagrams are given showing the details of construction. The method employed in the investigation of the double refraction was that used by Voigt in 1898. The absorption lines dealt with were the sodium D-lines and the red Li line. Diagrams and photographs are reproduced showing the appearance of the interference bands when the absorbing flame is subjected to the field of a Du Bois magnet. These are discussed as regards the general effects; a quantitative investigation and theoretical treatment will be given in a subsequent paper. A. W.

832. *Micro-azimometer.* **C. V. Burton.** (Phil. Mag. 23. pp. 385–400, March, 1912.)—The chief object of the device here described is to increase the sensitiveness of reflecting instruments by optical means, especially when the available reflecting surface is small. Thus it has been found possible when the (rectangular) aperture of the mirror is 3·5 mm. × 4 mm., to fix the azimuth of the mirror with a max. error of one-tenth of a second of arc. The apparatus is described in detail by aid of diagrams and a theory of it given. E. H. B.

833. *Quartz and Fluorite as Standards of Density and Refractive Index.* **H. E. Merwin.** (Amer. Journ. Sci. 32. pp. 429–432, Dec., 1911.)—Standards of density correct to 0·001, and of index correct to 0·0001 are particularly useful to the mineralogist. Quartz and fluorite are among the very few natural solids of wide distribution that are uniform enough in composition to approach such conditions. The relative density of twelve fragments of clearest quartz from different localities was investigated by suspending the fragments in Thoulet's solution. The solution was brought to the density of Brazilian pebble quartz, then the other fragments were put in. Only two fragments differed sensibly in density, one slowly settling, the other coming slowly to the top, and the difference in density even of these two was less than 0·0003. The density of any one of the twelve quartzes investigated is 2·6495 ± 0·0010, and this may be taken as the density at 20° C. of clear quartz from any locality. The decrease in density between 10° and 30° C. is about 0·001 per 10 deg. rise, according to Fizeau. Fragments of nearly colourless fluorite from nine different localities in Europe and America were suspended in Rohrbach's solution, and a maximum difference of density of 0·001 was observed. The mean density found by the Westphal balance was 3·180, with a probable error of 0·001. A study of the indices of refraction of five quartzes gave, by the Abbe-Pulfrich refractometer, an extreme difference of 0·00015. The index for two of them was 1·5443 —, for the three others 1·5442. According to Gifford, a rise in temperature of 20 deg. lowers the index 0·0001. The index of fluorite varies remarkably little; even the coloured varieties differ from the clear scarcely more than 0·0002. A rise of 3 deg. to 10 deg.

in temperature causes a decrease of 0·0001 in the index. *Three* plates of polished fluorite gave the following extreme values with sodium light: 1·4338 + and 1·4338 —. A. E.

834. *Absorption of Light by Inorganic Salts.* V. *Copper and the Alkali Metals.* **R. A. Houstoun.** (Roy. Soc. Edinburgh, Proc. 32. pp. 40–49, 1911–1912.)—A new spectrometer is described, provided with an interchangeable camera and thermopile, in which two concave mirrors of pure nickel and a quartz prism are used to give photometric measurements throughout the spectrum with one apparatus. A new photometric apparatus is also described, in which an iron arc is moved between two diffusely reflecting surfaces of opaque silica, the light from the two reflectors being brought together on the slit after passing through water or the solution under examination. Curves are given for copper sulphate, chloride, nitrate, and bromide, showing a very strong maximum of absorption at 0·8 μ on the lower limit of the visible region, and a limit of transmission at 0·24 μ in the extreme ultra-violet. T. M. L.

835. *Absorption of Light by Inorganic Salts.* VI. *The Cobalt Chloride Colour-change.* **A. R. Brown.** (Roy. Soc. Edinburgh, Proc. 32. pp. 50–61, 1911–1912.)—The blue colour of cobalt-chloride solutions at high temperatures or in presence of alcohol, is due to a band at 0·675 μ, which decreases in intensity and moves a little towards the infra-red by cooling or dilution. The red form owes its colour to a very much shallower band in the green at 0·510 μ, which is masked, however, by quite small quantities of the blue variety. Assuming that only these two varieties exist, their proportions can be calculated from the value of the maximum absorption-coefficient in the red, which in pure alcohol reaches the value 232, as contrasted with 6 for the highest value at the band in the green. The blue variety, occurring as it does in alcoholic solution, is regarded as anhydrous: the red variety is probably not the hexahydrate, of which the crystals give bands at 0·550 and 0·495 μ, and is assumed to be merely $CoCl_2 . nH_2O$; a calculation based upon the law of mass-action gave $n = 14·7$, so that the number of molecules of water in the red variety of cobalt chloride in solution is probably about 15. By subtracting from the figures for a saturated solution $\frac{9}{10}$ of the corresponding values for a dilute solution a difference-curve was obtained, which showed a band at 0·550 μ and a weaker band at 0·490 μ. This affords distinct evidence of small quantities of the hexahydrate in the solution. T. M. L.

836. *Optical Dispersion: A Comparison of the Maxima of Absorption and Selective Reflection for Certain Substances.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 86. pp. 1–14, Dec. 22, 1911.)—Using dispersion formulæ of a general type, such as $(n^2 - 1)/(n^2 + a) = \Sigma C_1/(\lambda^2 - \lambda_1^2)$, in place of the simple form $n^2 - 1 = \Sigma C_1/(\lambda^2 - \lambda_1^2)$, an expression is found for the position of the maximum of κ, the coefficient of extinction; further, a quartic equation is obtained, three of whose roots give the maximum of $n\kappa$, and the minimum and maximum of the refractive index n. Numerical examples of these formulæ are considered. Iodeosin, a substance for which the dispersion and absorption have been measured, is first chosen, and the positions of the various maxima are calculated and compared with experimental results. The remaining examples are carbon disulphide, rock-salt, and sodium vapour. For these substances dispersion formulæ are known in a form not involving absorption; the formulæ have been completed by introducing coefficients of suitable

value, and the maxima of absorption and of selective reflection have then been determined. The results illustrate the differences that may exist between these wave-lengths and the λ_1 of the simple dispersion formula; in the infra-red especially, where reflective power is large, the maximum of selective reflection is proved in general to be displaced considerably from the natural wave-length λ_1, or from the position of maximum absorption. A. E.

837. *Double Rainbow on the Surface of Water.* **J. Dechant.** (Akad. Wiss. Wien, Ber. 119. 2a. pp. 1057–1067, July, 1910.)—On calm mornings when there was heavy dew, double-coloured bows of hyperbolic form were seen on the surfaces of ponds at Schönbrunn, Vienna, especially in early March. The two arcs of each pair had a common axis, and lay in the same direction, so that one was wholly within the other. The order of the colours was the same in both. The vertex of the inner, and fainter, bow was missing for solar altitude 25°, which was the average altitude at the time. When one pool was covered by a non-reflecting coating of ice the principal bow only was seen in that pool, while double bows were seen in the remaining pools, which were unfrozen. The planes of polarisation for very distant neighbouring points of the two bows were observed to be very much inclined to one another, and to the horizon. The phenomenon is ascribed to the presence in the city atmosphere of numerous greasy particles, which fall upon the water surface on calm nights and form condensation nuclei for drops of dew. It is stated that, after the surface has been cleared by a breeze, masses of grease are found accumulated at the brink of the pools. The principal bow is explained as being formed by the dewdrops in the usual way, and reasons are given for attributing the fainter bow to light reflected at the water surface *before* entering the drops. A. E.

838. *Departures from Fresnel's Laws of Reflection.* **Rayleigh.** (Phil. Mag. 23. pp. 431–439, March, 1912.)—In 1907, in connection with the experiments on reflection from glass at the polarising angle, the author also made observations on the diamond—a subject in which Kelvin had expressed an interest. It was known from the work of Jamin and others that the polarisation of light reflected from this substance is very far from complete at any angle of incidence, and at first experiments were directed to ascertain whether this irregularity could be plausibly attributed to superficial films of foreign matter, such as so greatly influence the corresponding phenomena in the case of water. [See Abstract No. 1778 (1908).] The arrangements were of the simplest. The light from a paraffin flame seen edgeways was reflected from the diamond and examined with a nicol, the angle being varied until the reflection was a minimum. The results of repeated observations seemed to leave it improbable that any process of cleaning would do more than reduce the reflection at the polarising angle. Recently the experiments have been resumed with the same diamonds, but with such additions to the apparatus as are necessary for measuring the residual reflection. Besides the polarising nicol, there is required a quarter-wave mica plate and an analysing nicol, to be traversed successively by the light after reflection. The analysing nicol is set alternately at angles $\beta = \pm 45°$. At each of these angles extinction may be obtained by a suitable rotation of the polarising nicol; and the observation consists in determining the angle $\alpha' - \alpha$ between the two positions. Wiped with an ordinarily clean cloth, the diamond at first gave $\alpha' - \alpha = 2°{\cdot}3$. The best results were obtained when the surface was finally pressed repeatedly upon sheet asbestos which had been ignited a few minutes

earlier in the blowpipe flame. There is another departure from Fresnel's laws which is observed when a piece of plate-glass is immersed in a liquid of equal index. Under such circumstances the reflection ought to vanish. The liquid may consist of benzol and carbon bisulphide. If the adjustment is for yellow more benzol, or a higher temperature, will take the ray of equal index towards the blue, or *vice versâ.* In spite of the equality of index for the most luminous part of the spectrum, there is, for moderate angles of incidence, a pretty strong reflection of a candle flame, and apparently without colour. This reflection could be reduced, but not destroyed, by repolishing or treatment of the surface by hydrofluoric acid. The reflection from surfaces of fused quartz was found to sensibly disappear at the polarising angle. The difference $a' - a$ was inappreciable, and was probably not greater than 0·05°, *i.e.*, three minutes of arc. After discussing the non-disappearance in the other cases, the author concludes that the cause of the small residual reflection must remain for the present an open question. E. H. B.

839. *Peculiar Shadows during Partial Solar Eclipse.* **E. Edser.** (Nature, 89. pp. 216–217, May 2, 1912.)—During the partial eclipse of the sun on April 17, 1912, the shadows cast by leaves of trees on a white road were observed to be negative images of the visible solar crescent. The explanation is given as a particular instance of Babinet's principle, and applies equally to an observation made by Winn some years ago on shadows of small objects from large sources. In an ordinary pinhole camera the image is a positive inverted one; if in the place of the pinhole screen we interpose between the object and receiving screen a small opaque ball, this will cut off from the screen exactly those rays which previously, by themselves, passed through the pinhole and formed the inverted positive image. From this we see that now on the screen we shall see an inverted negative image of the object. In the case of the eclipse shadows the object was the uneclipsed solar crescent. This shows that when light from an extended source throws the shadow of a small object on a screen, under such conditions that the umbra of the shadow is not formed, then the shadow is the negative inverted image of the source of light.

C. P. B.

840. *Phototropism.* **L. Amaduzzi** and **M. Padoa.** (N. Cimento, 3. pp. 41–50, Jan., 1912.)—Phototropism, or the change of colour produced by light, was studied in certain hydrazones and other organic substances by dissolving them in benzol or other solvent and depositing them on metallic surfaces. The latter were then charged negatively and connected with an electrometer. The rate of discharge under ultra-violet light was measured before and after the change of colour had been induced by exposure to sunlight or to prolonged ultra-violet light from the arc. It was found that the change of colour is almost always accompanied by a change in the photoelectric behaviour. There is usually an increase, and fatigue is always observed. When the substances are heated to a temperature between 80° and 145° C., phototropism disappears, but prolonged exposure to ultra-violet light still produces a change in the photoelectric power. In general, there is no direct and clear relation between phototropism and photoelectric power. Ultra-violet light produces some photoelectric change which, under favourable circumstances, is accompanied by a change of colour. E. E. F.

841. *Heterochromatic Photometry.* **J. Thovert.** (Journ. de Physique, 2. Ser. 5. pp. 34–40, Jan., 1912.)—The author alludes to the distinction that has

been drawn between luminous intensity and "visual sensibility" in the sense of revealing detail. He describes tests of the distribution of brightness in the spectrum of various illuminants by two methods, one based on observation of fine detail in the illuminated field, the other on the ordinary "equality of brightness" method. The results are assembled in graphical form and compared with the well-known spectrum curves of Abney and others. The conclusion is drawn that the distribution of brightness in the spectrum and of efficacy for revealing form are substantially the same, the maximum under ordinary conditions being located near 0·56 μ–0·57 μ. An experiment is described which shows that the sharpest perception of colour (judged by dimming the spectrum until the colour becomes indistinguishable) is located nearer 0·52 μ. J. S. D.

842. *Magnetic Rotation by Massive Metal Mirrors.* **P. D. Foote.** (Phys. Rev. 34. pp. 96–109, Feb., 1912.)—By use of a Fuess spectral system and Lippich half nicol the magnetic rotation and ellipticity by reflection at normal incidence have been measured throughout the visible spectrum for massive mirrors of iron, cobalt, nickel, steel, invar, magnetite and Heusler's alloy with the results following. (1) The rotation is in reasonable agreement with the work of previous investigators. (2) The ellipticity was found to be consistent with the work done on transmission. For the majority of substances it was negative throughout, but for others (nickel, invar, and magnetite) it changed sign in the visible spectrum. (3) The ordinary optical constants obtained for iron, nickel, invar, and magnetite showed no evident connection existing between these and the magneto-optical constants. (4) As with transmitted light, the ellipticity of the reflected light was found proportional to the intensity of magnetisation for all wave-lengths. E. H. B.

843. *Optical Observations on an Active Liquid-crystalline Substance.* **F. Stumpf.** (Ann. d. Physik, 37. 2. pp. 351–379, Feb. 20, 1912. Extract from Dissertation, Göttingen.)—The substance investigated was *act*-amyl-*p*-cyanobenzalaminocinnammate. It becomes isotropic above 105°, yields a turbid liquid-crystalline form at 105–102°, and a second very clear liquid-crystalline form at 102° to 92°; this can be undercooled to 75°, and by the addition of cyanobenzalanisidine can be carried down to atmospheric temperatures. The optic axis of the liquid-crystal is perpendicular to the surfaces of the film and an extraordinary optical rotation (estimated by Vorlander and Huth at 18,000°/mm.) is produced in light travelling along it; the actual rotations are not, however, excessively large, as the regular orientation of the particles by the influence of the enclosing surfaces is limited to a total thickness of about 0·015 mm. In the present paper the refractive indices are given (*a*) for the solid phase at 18°, (*b*) for the ordinary and extraordinary rays of the liquid crystals from 75° to 95°, (*c*) for the isotropic liquid from 100° to 120° over the range of wave-lengths from 7400 to 4600. The values for the ordinary and extraordinary rays converge as the temperature rises, and the values for the isotropic phase form approximately a continuation of the line of average values. The optical rotatory power was investigated in mixtures of the active ester with the inactive base referred to previously. The mixture was enclosed between a glass plate and a glass lens, and when examined between crossed nicols showed a series of dark and light bands depending on the varying optical rotation produced by the different thicknesses of the substance. By placing the whole combination, illuminated by a Nernst lamp, in front of the slit of a spectrograph, the optical rotation for a series of different thicknesses

could be photographed throughout the spectrum. Mixtures of 1 part ester with ½ part base produced a minimum rotation of 15,000°/mm. at wave-length 5600 at 20°, rising to 86,000°/mm. at λ = 4620 and to 19,000°/mm. at λ = 6200; at higher temperatures (up to 60°) the minimum moves towards the red end of the spectrum; in this region one of the circularly-polarised rays is much more absorbed than the other, and the light emerges in an elliptically-polarised form. The pure ester was examined between 75° and 101·5°. It shows an absorption band about wave-length 5800, the rotations rising steadily as this wave-length is approached from the red end of the spectrum; but in none of the curves that are recorded was a minimum value reached on the red side of the band; this is in accord with the observations made with mixtures of ester and base from 20° to 60°, which showed the minimum vanishing into the infra-red at 60°. On the blue side of the band, however, minimum values were observed at each temperature, ranging from 25,800°/mm. for λ4700 at 75°, to 6700°/mm. for λ5100 at 101·5°; the drifting of the minimum is of the same character as in the case of the green-to-red band in mixtures of ester and base. The highest value recorded was a rotation of 87,700°/mm. for λ5160 at 75°. The paper also includes a detailed investigation of the wave-form of rays travelling obliquely to the axis. T. M. L.

844. *Absorption Bands on the Principles of Doppler-Fizeau and of W. Michelson.* **A. Perot.** (Journ. de Physique, 2. Ser. 5. pp. 171–176, March, 1912.)—W. Michelson has shown that, when, between a source of light and an observer, there are several media, and the surfaces separating the media are displaced, the length of the wave of light received is altered if the source is monochromatic. The duration of the passage of the light through the set of media is variable with the time, and there accordingly results an effect comparable to the effect of Doppler-Fizeau. A particular case has been recently observed by Dufour, namely, that in which a monochromatic source moves in a medium which can absorb the wave-length emitted. He has shown the influence of the abnormal dispersion, which makes the phenomenon different, according as the source recedes from or approaches the observer. Cotton has just drawn attention to the Michelson-effect in the case of bright rays emitted from a source, and states that the considerations he has developed may have an application in physical astronomy, especially in the study of the sun. The present paper deals, from the physical standpoint, with the case of a source of white light, which gives a continuous spectrum in the spectroscope. The special states to be expected just near the absorption band are shown by various figures. The application to the actual solar phenomena is reserved for a later paper. E. H. B.

845. *Diffraction Gratings with controlled Groove-form and Abnormal Distribution of Intensity.* **R. W. Wood.** (Phil. Mag. 23. pp. 310–317, Feb., 1912. Phys. Zeitschr. 13. pp. 261–264, April, 1912.)—In a previous paper [Abstract No. 420 (1903)] the author described a grating with a remarkable distribution of intensity in some of the spectra. In the present paper is described a still more remarkable grating which shows a bright line in the continuous spectrum of a white source of only 8 Å. units width. As the angle of incidence is varied the position of the bright line in the spectrum changes, and, what is of especial interest, its wave-length corresponds exactly to the wave-length which is just passing off from the grating at grazing emergence in the fourth-order spectrum. This is in agreement with the surmise of Rayleigh, that abnormalities are to be expected at such angles of incidence that spectra of higher orders are just passing off. The bright line in question appears in the first-order spectrum on the opposite side from that on which the grating concentrates light, and is about as bright as the continuous spectrum upon which it appears projected, so that the brilliancy at the point in question is about double that of the rest of the spectrum. Various experiments are described tending to elucidate the cause of these remarkable anomalies. It seems evident that they are to be referred to the action of the sharp ridges and not to the bottoms of the grooves, as they are profoundly modified by the lightest possible rubbing of the grating with soft chamois skin. A. W.

846. *Relation between Absorption Spectra of Metallic Ions and their Valency.* **C. R. Crymble.** (Chem. Soc., Journ. 101. pp. 266–273, Feb., 1912.)—The present investigation was confined to the absorption of light by metals in aqueous solution. It was found that the metallic elements may be divided into two groups: (i) those of constant valency, the salts of which in aqueous solution transmit the ultra-violet rays; and (ii) those of varying valency, the salts of which in aqueous solution absorb ultra-violet light. By non-absorptive is meant a normal solution, 10 mm. of which transmits all rays of wave-length greater than λ2350. A metal is here regarded as of constant valency when it yields only one series of salts, the valency being determined, not by the oxides of the metals, but by its fluorides or chlorides. If the metals are arranged according to their electrode-potential, the more electro-positive metals are found to be of constant valency and non-absorptive. [See also Abstract No. 1365 (1903).] A. W.

847. *Absorption Spectra of Phosphorescent Substances.* **B. Walter.** (Phys. Zeitschr. 13. pp. 6–11, Jan. 1, 1912.)—In the first part of this paper it is shown that the absorption spectra of the diphosphides of Ca, Sr, and Ba possess strong absorption bands, and further, that only those waves giving rise to strong phosphorescent light are strongly absorbed. The strength of this absorption is of the order of magnitude of that of fluorescent solutions. In the second part it is shown, principally from the observations of Lenard, that the wave-lengths of the rays which the phosphides of the alkaline earths give out, and which are therefore absorbed by them, are nearly or altogether independent of the nature of the active metals, and depend therefore essentially on the nature of the alkaline earths. These results, together with others, seem to support more the chemical theory of phosphorescence than the electron theory of Lenard. A. W.

848. *Width of Spectrum Lines.* **K. Eisenmann.** (Deutsch. Phys. Gesell., Verh. 14. 6. pp. 315–321, March 30, 1912.)—The width of an ultra-violet spectrum line is deduced as follows: $E = h\nu$ is the max. energy of an electron, and is the amount required for propagating vibrations [Einstein, Abstract No. 1524 (1911); Stark, Abstract No. 1087 (1908)]. This energy has a vibrational part U and a translational part L, so that $E = U + L = \frac{1}{2}m(u^2 + v^2)$. The speed $u = 2\pi r\nu$, where ν is the frequency of the (sinusoidal) oscillation, and r its amplitude. Thus $E = 2\pi^2 m r^2 \nu^2 + L$. It is also $= h\mu$, where μ is Planck's action quantum and μ a frequency characteristic of the element. Thus $h\mu = 2\pi^2 m r^2 \nu^2 + L$. The quantity L has a mean value $= \frac{1}{2}mv^2 = f(T)$, but to every actual value a value of ν must correspond such as to make the total energy $= h\mu$. Hence ν has a certain spectral width, while μ is monochromatic. A similar expression is deduced for the infra-red oscillations of an atom. Its max. energy in the solid state is attained when it is detached from the connection with its neighbouring atoms, *i.e.*, at fusion. The number of neighbouring atoms depends upon the system of crystallisation. The minimum is 27, in the regular system. The max. electronic and atomic energies are calculated for Al, Cu, Ag, Pb, Hg, Rb, K, Na, Li, Zn, and I. It is shown that Rb and Li probably crystallise in the tetragonal system.

E. E. F.

849. *Spark Spectra.* **G. A. Hemsalech.** (Comptes Rendus, 154. pp. 767–769, March 18, 1912.)—A paper on the influence of capacity, self-induction, and sparking distance on the velocity of projection of the luminous vapours in the electric spark. The method of determining the velocity of projection by means of an air-blast has previously been described [Abstract No. 1272 (1905)]. The research has been continued, a study having been made of the trajectories of the luminous vapours of different elements, in particular those of lead. Rays of various wave-lengths were examined, the velocity of the vapours being determined at various distances from the electrodes and for different capacities in the spark circuit. The tabulated results show that the velocity of the luminous vapour is not sensibly modified by variations of capacity; but, on the other hand, it varies inversely as the self-inductance of the discharge circuit, and directly as the sparking distance. The numbers given, although only indicating the order of magnitude of the velocities, are nevertheless sufficiently constant to allow of the application of this method to a comparative study of the velocities given in analogous conditions by the vapours of different elements. A. W.

850. *Variations of Hydrogen Spectrum.* **H. B. Lemon.** (Astrophys. Journ. 35. pp. 109–124, March, 1912.)—As regards the effect of temperature on the spectrum of hydrogen in a vacuum tube excited by alternating current, it was noticed that (1) a variation in the temperature of the discharge tube of from 800° to 100° abs. largely affects the relative amount of energy in the series and the compound line spectrum, the latter being much enhanced at the lower temperature; (2) this variation of temperature does not affect the relative intensities of the series, at least to within the limits of error of the experiment. [See Abstract No. 76 (1904).] C. P. B.

851. *Absorption Spectra of Lithium and Caesium.* **P. V. Bevan.** (Roy. Soc., Proc. Ser. A. 86. pp. 320–329, March 26, 1912.)—The present paper deals with a further study of the absorption spectra of the vapours of Li and Cs [see Abstract No. 869 (1911)]. The principal series lines of the two metals have been extended, and a more detailed examination made of the expression of the wave-lengths by a formula. Fourteen new lines from λ2305·82 to λ2302·15, in the Li absorption spectrum are tabulated, and it is shown that the 41 lines of the spectrum can be well expressed by the Hicks formula—

$$n = \mathrm{A} - \mathrm{N}/(m + \mu + \alpha m^{-1})^2,$$

where $\mathrm{A} = 48484{\cdot}8$, $\mu = 0{\cdot}951481$, $\alpha = 0{\cdot}007522$. It was found that a steady atmosphere of Cs vapour could be maintained by heating the anhydrous chloride with Li. With this method the series lines were photographed up to the 81st of the principal series, which, as with all the alkali metals except Li, consist of pairs of lines. The lines are not equally intense in all cases, the line of greater wave-length in a pair being the less intense. With Rydberg's notation the two series P_1 and P_2 can be expressed by the above Hicks formula, the values of the constants being: for P_1, $\mathrm{A} = 31404{\cdot}6$, $\mu = 1{\cdot}449975$,

$a = -0{\cdot}089294$; for P_2, $A = 81404{\cdot}6$, $\mu = 1{\cdot}418206$, $a = -0{\cdot}090002$. The values of μ and a were recalculated for the P_1 series of Na, K, and Rb, and it appears that $a/(\mu - 1)$ shows a regular decrease with increasing atomic weight. An investigation was made of the broadening effect in a pair of lines with increase of density of the vapour of Cs. It was found that in all cases, as with the pair specially dealt with, the broadening was asymmetrical, extending much further on the more refrangible side than on the other.

A. W.

852. *Vacuum-tube Spectra of Metals and Metallic Chlorides.* II. **J. H. Pollok.** (Roy. Dublin Soc., Proc. 13. 21. pp. 253–268, May, 1912.)—A continuation of work previously described [see Abstract No. 678 (1912)]. The substances dealt with were Pb, Fe, Mn, Ni, Co, Cr, Ba, Ca, Sr, Mg, K, Na, Li, and their chlorides. The generalisations arrived at in previous observations were confirmed. Bands were not so prominent a feature of the spectra of the compounds examined, except in the cases of Mn and Mg; with them a greater number of lines show when the condenser or Leyden jar is used, and the bands are less conspicuous. Apart from the bands, the spectra of the vapours of metallic chlorides appear to consist exclusively of the lines of the spark spectra of the metals of which they are composed, with or without the lines of Cl, together with the ultimate lines of any impurities present. There is, so far, no reason to believe that compounds give rise to extra lines in the spectrum; if such lines exist at all they are not a prominent feature of spectra, and are so faint that they are not likely to cause confusion in an analysis; so that if three or four prominent lines are obtained in a vacuum-tube spectrum, that cannot be identified as the ultimate lines of a known element, we may safely conclude that they are the ultimate lines of an unknown element. With bands it is quite otherwise. Different compounds appear to give rise to different bands, not in any way related to the spark spectra of the elements of which they are composed. The danger of confusion with bands is when only a small quantity of the compound that gives rise to them is present, when the band fades away and leaves only one or two prominent lines of the head of the band, which then have much the appearance of the lines of a line-spectrum. As a general rule, the strongest lines in the spark spectrum are the strongest lines in the vacuum-tube spectrum of an element; and, as a general rule, the ultimate lines in the vacuum-tube spectrum appear to be identical with the ultimate lines of the spark spectrum; but this is not always the case. Mn gives a very characteristic group of lines that are surprisingly persistent in the vacuum tube $\lambda 2801{\cdot}3$, $\lambda 2798{\cdot}5$, and $\lambda 2795{\cdot}3$, and these are quite different from the ultimate lines of the spark spectrum of Mn $\lambda 2605{\cdot}8$, $\lambda 2594{\cdot}0$, $\lambda 2576{\cdot}2$. Photographs of the various spectra are reproduced, and tables given of the principal lines for each element; the general character is in each case briefly discussed. A. W.

853. *Ultimate Lines of the Vacuum-tube Spectra of Manganese, Lead, Copper, and Lithium.* **G. V. Morrow.** (Roy. Dublin Soc., Proc. 13. 22. pp. 269–287, May, 1912.)—Recent advances in spectrum analysis have made it desirable that we should have an accurate knowledge of the ultimate lines of vacuum-tube spectra, as so far no accurate determinations of this kind have been made; and without a knowledge of the ultimate lines of the elements, it is often impossible to determine with certainty the origin of the lines of a complex spectrum. Quantitative spectroscopic analysis was first successfully applied by Hartley to the spark-spectra of the elements, solutions of known concentration being used. This work was continued by Pollok and Leonard [see Abstracts Nos. 1510, 1815 (1907), and 607 (1908)]. In the present investigation the type of quartz tube due to Pollok was used. They are composed entirely of quartz, and are open at each end, having the electrodes sealed into glass, and attached by rubber tubing. The general arrangement of the apparatus was also substantially the same [see Abstract No. 678 (1912)]. Solutions of the substances of graded strengths were introduced into the tubes, previously clean, and photographs taken. The wave-lengths of the lines were obtained by comparison with the Cd spark-spectrum, photographed on the middle of the spectrum under consideration. Tables are given of the wave-lengths, and indications are given of the order of persistency. It appears that the ultimate vacuum-tube lines of Mn are λ2801·8, λ2798·5, and λ2795·8 [see preceding Abstract]; the lines λ2605·8, λ2593·8, and λ2576·2, which are the ultimate lines in the spark-spectrum, disappear before the former three. One of the ultimate lines of Pb is λ4068·2. Copper chloride is only slightly volatile as compared with manganese chloride, 0·0001 gm. of which will give almost a complete spectrum in a vacuum tube. The ultimate lines of Cu appear to be λ3274·1 and λ3247·6. Lithium chloride, too is not very volatile; the ultimate lines are λ6708·2 and λ4602·4, the former being the more intense. Photographs are reproduced of the spectra given (i) by 0·1 mgm., (ii) by less than 0·1 mgm. and (iii) by the last traces of the substances. **A. W.**

854. *Short Wave-lengths in the Mercury Arc Spectrum.* **A. L. Hughes.** (Cambridge Phil. Soc., Proc. 16. No. 5. pp. 428–429, March 7, 1912.)—In experiments on the photoelectric effect it was found that the unresolved light from a quartz mercury lamp produced electrons of much greater velocities than those produced by the isolated group of wave-lengths between λ2300 and λ2400. Short-exposure photographs of the spectrum showed that the shortest wave-length was apparently about λ2300; but exposures of from 5 to 20 minutes gave further lines whose wave-lengths were determined by means of the well-known lines (λ1854, λ1862, λ1935, and λ1990) in the spectrum of the Al spark. The new wave-lengths are given in the following table with the wave-lengths attributed to the last three by Stark and by Steubing [see Abstract No. 79 (1910)].

	Stark.	Steubing.
1849	—	—
1909[1]	—	—
1941·5	1941·77	1940
1972	1972·86	1971
2002	2002·24	2000

[1] Appeared only on 3 plates. Very faint.

Photoelectric investigations showed that λ1849 was the shortest wave-length emitted by the mercury lamp employed. Previous work has shown that the mercury arc spectrum extends as far as λ1230 [Abstract No. 1209 (1911)] and that there is a gap between λ1780 and λ1450. Hence it appears that the absorption of quartz glass begins somewhere between λ1780 and λ1849. **A. W.**

855. *Arc Spectra.* **H. Oellers.** (Zeitschr. wiss. Phot. 10. pp. 374–392, Feb., and pp. 393–432, March, 1912.)—A lengthy paper on the nature and distribution of the emission in the arc spectra of the metals Cu, Ag, Mg, Ca, Zn, Cd, Al, Tl, Sn, investigated with a prism-camera and grating. The results of the research may be briefly summarised thus:—As a rule the emission is stronger at both poles; it decreases towards the middle of the arc and from the axis to the periphery. Usually the emission is stronger at one pole than the other; this pole may for different metals be the positive or the negative. Hollow flames never appear; the centre of the arc has the greatest emission. In some, but not in all cases, the arc splits into two flames, touching in the middle. Using a wide slit, as in the investigation of solar prominences, images of the flame, due to the various spectral lines, are obtained. The flame images of the strongest (longest) lines are the largest, those of the weakest lines the smallest. The size of the flame images for different series corresponds to the intensity. Flame images of bands are usually weaker at the electrodes, stronger in the middle of the arc. The results are discussed at length and comparison is made with earlier researches.

A. W.

856. *Stark-Doppler Effect for Hydrogen Canal Rays in Air.* **G. S. Fulcher.** (Astrophys. Journ. 35. pp. 101–108, March, 1912. Phys. Zeitschr. 13. pp. 224–228, March 15, 1912.)—In a previous attempt [Abstract No. 510 (1911)] to explain the details of the Stark-Doppler effect it was assumed that the collisions of canal rays with gas molecules obey the laws of ordinary, perfectly elastic impact. This involved two other rather improbable assumptions, so test experiments were undertaken. The apparatus was arranged so that a fine beam of canal rays, after passing through a 0·2-mm. hole in the kathode, was projected axially into a capillary about 0·3 mm. in diam. Hydrogen was supplied continuously to the discharge chamber through a second capillary behind the kathode at a rate regulated by a third capillary and gas reservoir. The gases mixed in the chamber behind the kathode, and were pumped away continuously by a Gaede pump. In the main capillary the only possible sources of the hydrogen lines were the hydrogen canal rays, luminescent as a result of their collision with air molecules. It was necessary only to examine the hydrogen lines for the Stark-effect to determine whether or not these rays were stopped by their collisions with air molecules. The results show that when hydrogen canal rays bombard hydrogen molecules the series lines $H\beta$ and $H\gamma$ show the Stark-effect very clearly. The "rest" line is seen to be distinctly separated from the broad "displaced" line by an "intensity minimum." When, however, the hydrogen canal rays bombard air molecules the displaced line alone is obtained. From these and other considerations it seems probable that canal rays emit light chiefly as a result of collision with gas molecules, and that such collisions are not perfectly elastic, but that the rays retain a large proportion of their momentum after the collisions, and do not impart much momentum to the hit molecules. When nitrogen canal rays (5000 volts) bombard hydrogen molecules the negative bands alone are produced, and these show a Doppler-effect. Investigation shows that the negative bands of nitrogen are emitted by the nitrogen molecules when ionised by kathode rays [Abstract No. 372 (1912)], and also as a result of collision with hydrogen molecules.

A. W.

857. *Asymmetry of Zeeman Triplets.* **F. Paschen.** (Phys. Zeitschr. 13. pp. 252–258, March 15, 1912.)—A criticism of some of Risco's statements and results [Abstract No. 679 (1912)]. Dealing with the yellow Hg line 5790·87 and its satellite 5789·88, the principal line, being the head of the first subordinate series of simple lines, should in a magnetic field be resolved into a normal triplet. Its anomalous behaviour is accounted for by the similar oscillations of its close satellite. **A. W.**

858. *Studies in Luminescence.* XVI. *Fluorescence and Absorption of certain Uranyl Salts.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 33. pp. 354–378, Nov., 1911.)—The chief purpose of the investigation was to determine whether the different bands of the luminescence spectrum are to be regarded as independent bands, each with its own region of excitation, or form a connected series, such that the excitation of one band necessarily involves the excitation of all. In all the salts studied the general appearance of the luminescence spectrum was much the same, although the bands differed somewhat in width in different salts. The luminescence spectra of different salts appeared to differ from one another chiefly as the result of a shift of the spectrum as a whole. In all cases the bands in the intermediate region of the spectrum were stronger than those towards the extremities. The distribution of energy among the different bands of the series in the uranyl salts seems to be very similar to the distribution of energy in a single band of a luminescent substance like fluorescein or Sidot blende. The distribution of energy in a single band is very similar to the distribution among the several bands. It is known that the width of each of the uranyl bands depends upon the temperature, the bands being almost as narrow as lines at the temperature of liquid air, and about 100 Å. in width at ordinary temperatures. It seems probable that at still higher temperatures this broadening would continue, and that finally the series of bands would overlap to such an extent as to appear as a single band. It is not unlikely that in the case of many luminescent substances the conditions at ordinary temperatures are those which probably obtain for the uranyl salts at high temperatures, and that the broad luminescence band of a substance like fluorescein is in reality the result of the overlapping of a series of bands. The relative intensities of the different bands were determined for several salts by the authors, and the results are given. It seems clear that the law of distribution of energy among the bands is much the same for all of the salts studied. The shift in wave-length of the bands in passing from one salt to another does not appear to bear any simple relation to the molecular weight of the salt or of its acid component. In comparing, however, the anhydrous and the crystalline nitrate, a slight shift toward the longer waves is found in the latter. This seems reasonable on account of the added weight of the water of crystallisation. Measures were made of the intensities of the three brightest bands for excitation by different ultra-violet lines of the quartz mercury lamp, in order to test whether wave-lengths might be found which would excite one band and not the rest. The results indicate that the first effect of excitation, whatever the wave-length of the exciting light, is to produce all the bands with a definite and constant intensity distribution, such variations as were found being attributable to selective absorption by the salt. Experiments were made on uranyl-potassium-sulphate to determine the relative effectiveness of different wave-lengths in producing fluorescence, and particularly whether rays falling within the sharp absorption bands at 4918, 4760, &c., were specially effective. It is clear that the ability to excite luminescence is not confined to rays falling within the narrow absorption bands, but extends to the region of general absorption lying between. Probably the specific exciting power varies only slightly with the wave-length, as was found with

eosin. Both the fluorescence and absorption bands of uranyl salts show a slight shift in wave-length with temperature. New bands, not seen at ordinary temperatures, become easily observable at the temperature of liquid air. At low temperatures the fluorescence and absorption bands appear much sharper than at ordinary temperatures, but in the case of the absorption bands there is some doubt as to whether the narrowing is as great as appears to the eye. In 1885 H. Becquerel published wave-length measures for uranium nitrate indicating that the frequency-difference is constant throughout the series of luminescence bands, and remains constant in passing from the luminescence to the absorption spectrum, thus bearing out E. Becquerel's suggestion that the absorption and emission bands belong to the same series. H. Becquerel also showed that two of the bands were reversible. The authors' work with the double sulphate of uranium and potassium confirms H. Becquerel's conclusions so far as the existence of reversible bands is concerned, and they find a third such band. They also find the frequency increment for the luminescence bands to be very nearly constant. But this increment does not appear to have the same value for the absorption bands as for the luminescence bands, and there is thus a distinct break in the series in passing from luminescence to absorption. Uranyl sulphate has the peculiarity of possessing two series of fluorescence bands lying close together, one set much more intense than the other. The absorption bands are also double, but it is curious to note the stronger components lie to the left (shorter w.l.) in the absorption series, whereas they lie to the right in the luminescence series. A. E.

859. *Growth of Radium C from Radium B.* **K. Fajans** and **W. Makower.** (Phil. Mag. 23. pp. 292–301, Feb., 1912.)—It has recently been shown by Fajans [Abstract No. 1351 (1911)] that the product RaC_2, discovered by Hahn and Meitner, has a period of 1·4 minutes and emits β-rays and that the α-rays from RaC cannot be ascribed either to RaC_2 or to an unknown product following it in the direct radio-active series. Further, Fajans' results suggest that RaC_2 is not in the direct line of disintegration products of radium between RaC_1 and RaD, but constitutes a side branch from the main series, so that RaC_1 may give rise on disintegration either to RaD or to RaC_2. The present paper deals with experiments on the subject to find out whether the whole of the β-radiation from RaC is due to RaC_2, and also what proportion of the atoms of RaC_1 give rise to RaD and RaC_2, respectively. The method adopted consists in measuring the curve of variation with time of the β-ray activity of a plate originally coated with pure RaB obtained by recoil from RaA. The curves were obtained using soft rays and hard rays, and were compared with the theoretical curves which should be obtained under the various assumptions. The results show (1) the α-rays as well as the greater part of the β-rays from RaC belong to RaC_1; (2) the ionisation of the β-rays from RaC_2 compared with that of the rays from RaC_1 is so small that it could not be detected in the experiments; (3) the β-rays from RaB fall into two groups whose coefficients of absorption are respectively 13 cm.$^{-1}$ and 91 cm.$^{-1}$. The ionisation produced by the former amounts to only about 1½ per cent. of the whole ionisation due to RaB. The results confirm the view that only a small fraction of the atoms of RaC_1 disintegrate into atoms of RaC_2. E. M.

860. *γ-Radiation from Radium B.* **H. G. J. Moseley** and **W. Makower.** (Phil. Mag. 23. pp. 302–310, Feb., 1912.)—In the experiments described in the preceding Abstract it was shown that RaB emits a small amount of very penetrating β-radiation. It therefore might be expected that RaB should also emit hard γ-radiation, and the present paper deals with an examination of the question. The method of investigation used is the same as that of Fajans and Makower, except that measurements of the various curves were all made through sufficient lead to absorb all the β-rays from RaB and RaC. The experiments show that RaB emits no very penetrating γ-rays, but emits a soft γ-radiation whose absorption coefficient for lead is about 4 cm.$^{-1}$ between thicknesses 8 mm. and 6 mm. and about 6 m.$^{-1}$ between 1 mm. and 1·7 mm. These soft γ-rays contribute about 12 per cent. to the total ionisation produced by the active deposit measured through 8 mm. of lead, and not more than 1 per cent. through 2·8 cm. of lead. An examination of the various curves also showed that RaC, if it emits γ-rays at all, gives an amount too small to be detected by the method used. The existence of the soft γ-rays from RaB is important in comparisons of quantities of radium by the γ-ray method as it is necessary either that the two quantities of radium to be compared should be surrounded by exactly the same thickness of envelope, or that a very thick walled lead electroscope should be used. In an appendix to the paper the authors give tables for the calculation of the rise and fall of activity of radium emanation and active deposit under various conditions. E. M.

861. *Ranges of α-Particles from Uranium.* **H. Geiger** and **J. M. Nuttall.** (Phil. Mag. 23. pp. 439–445, March, 1912.)—Boltwood, and Geiger and Rutherford (Abstracts Nos. 1100 (1908) and 850 (1911)] have shown that Ur emits two α-particles. Marsden and Barratt [Abstract No. 1848 (1911)] have shown that these are not given off simultaneously. Thus the particles must be ascribed to two successive α-ray products. In a former paper by the authors [Abstract No. 168 (1912)] an empirical relation between the range and transformation constant of α-ray products was given. This law indicates that unless the two products have the same period the ranges of the α-particles must differ. In the present paper experiments are described which show that α-particles of two different ranges are actually given off from pure uranium, the values found being 2·5 cm. and 2·9 cm. in air at atmospheric pressure and at 15° C. The method used is to compare the Bragg ionisation curves of Ur, Pol and Ionium in hydrogen, using a specially designed apparatus. The curves of the two latter are exactly similar; the curve for Ur, however, has a less conspicuous "knee" indicative of two ranges. No evidence was obtained of α-particles of range 1·6 cm. as recently suggested by Friedmann [Abstract No. 699 (1912)]. The above figure for the range of Ur, viz., 2·5 cm., is in much better agreement with the straight-line relation between the logarithms of the ranges and transformation constants of the α-ray products of the Ur-Ra family. Hence it is deduced that Ur.I, which has a period of 5×10^9 years and emits α-particles of range 2·5 cm., is followed by another α-ray product Ur.II, which has a period of about 2×10^6 years and emits α-particles of range 2·9 cm. These two substances must have chemical properties very closely allied. The period of ionium is also deduced to be about 2×10^5 years. E. M.

862. *Absorption Problems in Radio-activity.* **L. V. King.** (Phil. Mag. 23. pp. 242–250, Feb., 1912.)—The intensity of β- and γ-rays in their passage through matter decreases approximately according to the exponential law $I = I_0 e^{-kx}$, I_0 being the intensity at an arbitrary origin $x = 0$ as measured

by the ionising power of the rays, and K the coefficient of absorption. Under these conditions it can easily be shown that the intensity at a distance *r* from a point source of rays in a medium whose coefficient of absorption is *k* is given by $I = se^{-kr}/r^2$, *s* being the intensity at unit distance when there is no absorption. The author proceeds to calculate the formulæ for the conditions of absorption generally employed in practice. A case considered is that of the radiation at a point due to a homogeneous distribution of radio-active matter throughout an infinite slab of thickness *h*. It is shown that in the practical case of the decrease of γ-radiation with altitude above the earth, almost the whole effect is due to the upper 10 cm. of the earth's crust. This is important in measurements made in balloons owing to ballast, &c. Formulæ are also developed for the absorption by flat plates under various circumstances. E. M.

863. *Synthesis of Complementary Colours by Ruled Gratings.* **E. Estanave.** (Comptes Rendus, 153. pp. 1464–1466, Dec. 26, 1911.)

864. *Cosine Law of Radiation.* **L. V. King.** (Phil. Mag. 23. pp. 237–242, Feb., 1912.)—A mathematical discussion. E. H. B.

865. *Polarisation-ratios of Light from Metal Gratings.* **B. Pogány.** (Ann. d. Physik, 37. 2. pp. 257–288, Feb. 20, 1912.)—Mathematical theory is given and experiments described which show that although an exact quantitative agreement between theory and observation is not to be expected, yet the Rayleigh-Voigt theory is on the whole supported by the phenomena observed. Does not admit of brief abstract. A. W.

866. *Normal Wave-lengths of Iron Arc Spectrum.* **F. Goos.** (Zeitschr. wiss. Phot. 11. pp. 1–12, April, 1912. Astrophys. Journ. 35. pp. 221–232, April, 1912.)—The spectrum of the iron arc was photographed with a Littrow form of spectrograph having a plane grating with 7000 lines to the inch. Wave-lengths of the reduced lines between λ4282 and λ5824 are given on the international system. C. P. B.

867. *Mercury Spectrum.* **G. Wendt.** (Ann. d. Physik, 37. 3. pp. 535–560, March 8, 1912. From Dissertation, Tübingen.)—Earlier work by various experimenters [see Abstracts Nos. 827, 1145 (1907); 1105 (1908); 878 (1911), &c.] is first discussed, after which a description is given of research on (i) the wave-length differences of the satellites of the Hg lines; (ii) the variation of certain Hg lines and their satellites, due to increased foreign gas pressure, in a mercury arc lamp and a Geissler tube; (iii) the variation of the Hg spectrum with rarefaction of the Hg vapour; (iv) the influence of a magnetic field. A. W.

868. *Properties of the Rays producing Aurora Borealis.* **L. Vegard.** (Phil. Mag. 23. pp. 211–237, Feb., 1912.)

869. *Phosphorescence at Low Temperatures.* **J. de Kowalski.** (Phys. Zeitschr. 12. pp. 956–968; Discussion, pp. 968–969, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe. Archives des Sciences, 33. pp. 5–27, Jan., 1912.)—A more complete account of the phenomena described in Abstract No. 846 (1911).

870. *Radio-activity.* **B. B. Boltwood.** (Amer. Phil. Soc., Proc. 50. pp. 338–346, July–Aug., 1911.)—A semi-popular *résumé* as to the state of present knowledge in this domain. E. H. B.

HEAT.

871. *Thermal Regulator.* **E. Esclangon.** (Comptes Rendus, 154. pp. 178–181, Jan. 22, 1912.)—A new regulator is described consisting of two mercury columns, with reservoir suspended from the arms of a delicately poised balance. The tube forming the regulating column is furnished with a metal top, containing a saturated vapour with a small excess of liquid on the upper surface of the mercury. The other arm of the balance supports a simple barometric column. Adjustments are providing for varying the rate and degree of regulation. It is stated that the regulation may be easily adjusted to several hundredths of a degree. C. P. B.

872. *A New Form of Calorimeter.* **C. Féry.** (Comptes Rendus, 154. pp. 691–693, March 11, 1912.)—The principle on which this new calorimeter is based, is the use of the metal of the ordinary bomb form of calorimeter, as one element of a thermoelectric couple. The heat produced by the combustion of the fuel in an atmosphere of compressed oxygen, then produces an electric current in an external circuit, and a delicate voltmeter is employed to read off the e.m.f. produced. It has been found by direct experiment that the value of one division of the millivoltmeter scale expressed as calories, is independent either of the weight of combustible employed for the test, or of its nature—and it is therefore possible to make the scale of the voltmeter record directly the number of calories liberated by the combustion of the fuel. The use of water is dispensed with in this form of calorimeter, and the bomb is held in its place within a metal enclosure by two discs of constantan, the lower of which serves as the second element of the thermo-couple. J. B. C. K.

873. *Thermal Expansion of Fused Quartz.* **K. Scheel.** (Zeitschr. Instrumentenk. 32. pp. 14–18, Jan., 1912.)—Researches from the year 1900 to the present day are quoted; the range of temperature being from $-190°$ to $1000°$ C. The expansion curve is linear at high temperature, whereas between $-40°$ and $-80°$ (according to the specimen) there is a minimum length. Below these temperatures the coefficient is negative. The full empirical formulæ are quoted and may be summarised as follows:—

(1) From $-190°$ to $0°$ (Scheel).

$$l_t = l_0(1 + 0{\cdot}302 \times 10^{-6}t + 0{\cdot}00203 \times 10^{-6}t^2 - 0{\cdot}00000252 \times 10^{-6}t^3).$$

(2) From $0°$ to $100°$ (Chappuis, Scheel).

$$l_t = l_0(1 + 0{\cdot}358 \times 10^{-6}t + 0{\cdot}00181 \times 10^{-6}t^2).$$

(3) From $100°$ to $1000°$ (Callendar, Holborn and Henning, Randall).

$$l_t = l_0(1 + 0{\cdot}55 \times 10^{-6}t).$$

P. E. S.

874. *Range of High-temperature Mercury Thermometers.* **H. F. Wiebe.** (Zeitschr. Instrumentenk., Beib. 3. pp. 21–23, Feb. 1, and 4. pp. 33–40, Feb. 15, 1912. Communication from the Physikal. Techn. Reichsanstalt.)—The thermometers are made of Jena boro-silicate 59^{III} and filled under pressure; although they should legally be calibrated up to 510° C. only, they are sometimes calibrated up to 550°. The slow changes affect particularly the ice-

point. The ageing should be continued at 500° for at least 10 days; this heating is much more important than the subsequent slow cooling, the thermal depression being very small with this particular glass. The long-duration tests were made years ago, but particulars had not been published so far. H. C. Dickinson came to the same conclusion with regard to the glass 59^{III} in 1906. Jena combustion-tube glass will answer for thermometers up to 575° C. H. B.

875. *Variation of the Specific Heat of Water, with Experiments by a New Method.* **H. L. Callendar.** (Roy. Soc., Phil. Trans. 212. pp. 1–32, April 16, 1912.)—The results obtained by different observers for the specific heat of water between 50° and 100° C. are so discordant, that the author has carried out fresh investigations on the subject. To elucidate the points at issue, however, the experimental evidence already in existence is reviewed in detail, and the results exhibited graphically. The following formula is found to be the most suitable for showing the relation between the specific heat (s) and the temperature (t): $s = 0{\cdot}98536 + 0{\cdot}504/(t + 20) + 0{\cdot}0084t/100 + 0{\cdot}009(t/100)^2$. It was obtained by combining a formula with Regnault's coefficients to represent the variation from 100° to 200° C., with a formula containing a reciprocal term to represent the rapid fall in the neighbourhood of 0° C. The value of the constant term, 0·98536, is adjusted to make $s = 1$ when $t = 20$° C. A new continuous-mixture method is described for measuring the ratio of the mean specific heats over a range of temperatures varying between 25° and 100° C. The *same current* of water is passed twice through an arrangement of concentric tubes, called a "heat-exchanger," first as a hot current, and then, after suitable cooling, as a cold current, or *vice versâ*. The temperatures of both currents are measured by means of a platinum thermometer both on entering and leaving the heat-exchanger. With a flow of 10 cm.^{3} per sec. the heat-exchange amounts to about 800 cals. per sec., and the external heat-loss can be reduced to less than a tenth of a calorie per sec., or about 1 in 8000 of the total quantity measured. The conditions become steady to 0·002° C. in a few minutes when the rate of flow is changed, and the accuracy attainable depends chiefly on the limit of accuracy in reading the thermometers. The results obtained are in full agreement (to within 1 in 5000) with the author's formula, and point to some error in the work of both Bousfield and Lüdin at temperatures between 80° and 100°. This may be attributed mainly to fundamental differences in the thermometric and calorimetric methods employed. The author's own work, together with that of Barnes, shows that the whole variation of the specific heat of water between 10° and 80° C. is less than 0·5 per cent. Tables are given showing the specific heat of water at t° C. for each degree from 0° to 200° C. in terms of the specific heat at 20° C. taken as unity, and of the variation of the total heat of water, reckoned from 0° C., over the same range of temperature and in the same terms. T. S. P.

876. *Evaporation of Superheated Liquids in Presence of their Vapour.* **Marcelin.** (Comptes Rendus, 154. pp. 587–589, Feb. 26, 1912.)—The velocity of evaporation of a liquid in contact with its vapour does not depend merely on the rate of diffusion of the vapour from the surface, but still more upon the rate of flow of heat to the surface of the liquid to replace the heat lost by evaporation. This can be tested by experiments on liquids strongly superheated in tubes not more than 1·5 mm. in diam., in which the flow of heat is almost entirely radial and can be expressed by a simple formula. By equating the flow of heat from the bath to the loss of heat by evaporation,

it is possible to deduce an equation between the rate of evaporation and the linear dimensions and temperatures concerned. Three relationships deduced from this equation were tested in the case of ether and found to hold extremely well. T. M. L.

877. *Test of a Method for deducing the Ratio of the Specific Heats of Gases from Measurements of Volume.* **M. Guéritot.** (Comptes Rendus, 154, pp. 589–591, Feb. 26, 1912.)—Two 60-litre flasks are provided with pistons 5 cm. in diam. and are joined together through a tap. The gas in one flask is compressed isothermally and is then put momentarily in contact with the gas in the other flask. From the relative displacements of the pistons the ratio of the isothermal and adiabatic specific heats can be calculated. Actual values obtained were—

Air	$1{\cdot}39_4$
Air dry and free from CO_2	$1{\cdot}40_3$
CO_2 dry, containing 0·005 of air	$1{\cdot}29_1$

The whole apparatus is self-contained, and can be enclosed in a thermostat; it is therefore suitable for measuring the ratio of the specific heats at high temperatures and high pressures. T. M. L.

878. *Electron Theory of Specific Heat.* **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 14. 5. pp. 275–281, March 15, 1912.)—According to Nernst and Eucken, the free electrons have no influence on the specific heat of a metal. The author advances some considerations to show that they have. The temperature coefficient of the Hall-effect in non-magnetic metals shows that the number of free electrons somewhat decreases at higher temperatures. Hence the max. value of c_v, which should be above 6, should slightly decrease on heating, whereas c_p should remain nearly constant at high temperatures. If electrons have no part in the specific heat the max. value of c_v should not exceed 6, whereas c_p should increase continually. This reasoning is examined in the light of the figures given by White and by Kunz. They show that c_p approaches a maximum while c_v becomes constant or even decreases slightly. This points towards the electrons having a part in the specific heat, though it is quite feasible to introduce other hypotheses to account for c_v becoming larger than 6. If it never does, it follows that free electrons do not take part in the specific heat, but derive their energy from the ions, in some such way as the interchange of energy between connected pendulums. The electrons would then become free as soon as they had acquired the maximum energy from the ions. E. E. F.

879. *Connection between Temperature and Efficiency of Incandescent Filaments.* **M. v. Pirani** and **A. R. Meyer.** (Deutsch. Phys. Gesell., Verh. 14. 5. pp. 218–222, March 15, 1912. Elektrotechn. Zeitschr. 33. pp. 456–459, May 2, 1912.)—The authors present a series of tables showing the connection between the watts per candle and the black-body and true temperatures of tungsten, tantalum, and carbon filament lamps; the temperatures (true) range from about 1500° to 3000° C., and the corresponding specific consumption from 12·5 to 0·25 watts per hefner. Curves are plotted showing the application of the Wien law to a black body, and also that another similar relation (*i.e.*, between the absolute temperature and the intrinsic brilliancy in hefners per mm.^{2}) applies to all the three types of lamps mentioned above. The researches on the black body also bear out Haber's suggestion that the visible spectrum can be expressed in terms of a mean

wave-length which is dependent on the temperature of incandescence and the sensitiveness of the eye. For pure thermal radiation, and within the limits of temperature considered in this research, this wave-length can be taken as 0·586 μ. J. S. D.

880. *Radiation Constant.* **G. A. Shakespear.** (Roy. Soc., Proc. Ser. A. 86. pp. 180–196, Feb. 20, 1912.)—According to Stefan's law, the rate of radiation of energy from a full radiator in surroundings at a temperature of absolute zero is $\sigma\theta^4$ ergs per cm.^{2} per sec., where θ is the absolute temperature of the radiator. The classical determination of the constant σ is due to Kurlbaum, who used a surface bolometer with a platinum-black surface. The rise of temperature of the bolometer when exposed to the radiation from an approximately full radiator or "black body" was observed. Kurlbaum's result was characterised by the figures 5·38, but later work suggested this was too low. Other results were 5·48, 5·8, and 6·51. By a new arrangement with a lamp-black surface as radiator the author finds the mean value of the radiation constant to be—

$$\sigma = 5{\cdot}67 \times 10^{-12} \text{ watts per cm.}^2 \text{ per deg.}^4,$$
$$\text{or } 5{\cdot}67 \times 10^{-5} \text{ ergs per cm.}^2 \text{ per sec. per deg.}^4.$$

[See Abstracts Nos. 1881 (1898) and 1070 (1909).] E. H. B.

881. *The Flow of Energy.* **M. Laue.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 825–828, Feb. 22, 1912.)—Laue replies to van der Waals, Jr. [Abstract No. 1668 (1911)], by pointing out that we cannot distinguish the individual particles constituting the flow of energy as we can in the case of matter, and thus Einstein's addition theorem does not apply. He shows, independently of any special theory, that the velocity of energy cannot be transformed in the same way as the velocity of a material point, and believes that no great importance can be attributed to the conception of the velocity of energy. **J. D. van der Waals, Jr.** (Ibid. 14. pp. 828–831, Feb. 22, 1912.)—Van der Waals, Jr., points out that Laue's objection with regard to the impossibility of individualising portions of energy also applies to electric currents. Also, in elastic bodies a current of energy is logically assumed, though experimentally unverifiable. The whole relativity principle is a logical rather than an empirical expedient, and, but for a certain bias in favour of the existence of the ether, it would be quite feasible to adopt Ritz's assumption [Abstract No. 836 (1908)] that the velocity of the source is added to the velocity of light. E. E. F.

882. *The Discontinuity of Temperature at the Boundary between Metal and Gas.* **P. Lasareff.** (Ann. d. Physik, 37. 2. pp. 233–246, Feb. 20, 1912.)—The thermal conductivity of gases only possesses at medium pressures a constant value independent of the pressure. At small pressures a diminution of the transport of heat occurs, which decreases with lowering of the pressure of the gas. Smoluchowski's investigations have shown that the irregularities may be explained by assuming that at the boundary between the wall of the vessel and the gas a difference of temperature is produced which can be expressed by the equation $\theta' - \theta = \gamma \, . \, d\theta/dn$, where θ' is the temperature of the wall, θ that of the gas, $d\theta/dn$ the temperature gradient at the boundary between metal and gas and γ the so-called "temperature-jump-coefficient," *i.e.*, a magnitude which can be expressed by the equation $\gamma = \alpha \, . \, 760/p$, where p is the gas pressure in mm. and α a characteristic constant for each gas.

Various researches on the distribution of temperature in the immediate neighbourhood of the solid wall have been made by the method of cooling and otherwise, and the author has investigated this distribution by means of thermoelectric sounds and applied his method to find the thermal conductivity of air, hydrogen, and CO_2. From numerous observations the author concludes that γ for a given gas pressure is not a constant magnitude; it depends on the adsorption of the gas at the metal walls, and therefore varies within certain limits. The value of γ which expresses the discontinuity of temperature at the boundary of metal and gas was calculated from measurements of the temperature gradient within the heat-conducting layer of gas near the boundary, and agrees numerically within limits of errors of observation with the values found by Smoluchowski by the method of cooling. The measurements show that this discontinuity of temperature occurs in the layer of gas close to the solid wall, and depends on a continuous decrease of the coefficient of thermal conductivity in the same. The thickness of this transition layer is of the same order of magnitude as the mean free path of the gas molecules. J. J. S.

883. *Some Mechanical Phenomena of Gaseous Combustion.* **J. Meunier.** (Comptes Rendus, 154. pp. 698–700, March 11, 1912.)—When a small jet flame (wick lamp) is brought up to a butterfly gas-burner, the jet is attracted until it partly unites with the big flame, into which incandescent filaments are seen to enter. When the gas of the pilot flame has itself a considerable velocity, it surrounds the big flame in one or several spirals. Similar phenomena are sometimes noticed when logs of wood are burning in a fire, and the author suggests a cosmical analogy with the spiral nebulæ. H. B.

884. *Reversibility in Relation to Entropy and to Adiabatic Processes.* **T. B. Morley.** (Engineer, 113. pp. 457–458, May 3, 1912.)

SOUND.

885. *Acoustic Shadow of a Rigid Sphere.* **G. W. Stewart.** (Phys. Rev. 33. pp. 467–479, Dec., 1911.)—This paper discusses the acoustic shadow of a rigid sphere in terms of the intensities due to pressures, when the source is located on the sphere and the distances at which the intensities are determined are not large in comparison with the sphere. The analysis of the problem is presented, and two applications of the solution are made, viz., (1) the effectiveness of reflecting surfaces when placed in various positions in the neighbourhood of the speaker, (2) the apparent intensities of sound from a source at a distance as dependent upon the position of the head, which is of interest because of its bearing upon the perception of the direction of sound. E. H. B.

886. *Sound Intensity Determination.* **K. Heindlhofer.** (Ann. d. Physik, 37. 2. pp. 247–256, Feb. 20, 1912.)—This paper gives the mathematical theory of a proposed method for determining the absolute intensity of a sound from its thermal effect. Such a method imposes as conditions, the use of a detector of high thermometric sensibility and very small heat capacity. For this is proposed a very thin gold leaf about 2 μ thick, in series with a coil and a constant e.m.f. The temperature variations of the gold leaf generate an alternating current in a secondary coil, and from this the amplitude of the sound may be theoretically derived. E. H. B.

887. *Flow of Acoustic Energy from the Head.* **H. Zwaardemaker.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 758–768, Feb. 22, 1912.) —Records experiments by P. Nikiforowsky as to the flow of acoustic energy from the head whilst the sound was produced by the vocal organs or from the crown of the head along the stem of a vibrating fork placed there. The problem attacked was the following: How does the vocal energy distribute itself over the natural egresses (mouth, nose, and ears) and the hard and soft parts of the skull and face. The total activity of the sounds used was of the order 1 to 7 megaergs per sec. The results are given in tables from one of which the following extract is taken. Acoustic activity when *a* was sounded with the chest voice, 2·68 megaergs per sec. This was distributed thus: Both nostrils, 0·144; mouth, 2·306; both ears, 0·00014; bony parts of the head, 0·066; soft parts, 0·166. E. H. B.

888. *Bells.* **G. Sizes.** (Comptes Rendus, 154. pp. 340–342, Feb. 5, 1912.) —Gives tables of the partials detected in certain bells. [See Abstract No. 646 (1908).] E. H. B.

889. *Combination Tones.* **L. Hermann.** (Ann. d. Physik, 37. 3. pp. 425–434, March 8, 1912.)—A review of the views held by Helmholtz and his successors C. Schaefer, F. A. Schulze, and E. Waetzmann. The present author still feels to the Helmholtz theory an objection (raised by him in 1891) as to the legitimacy of treating a certain factor as negligibly small. [See Abstracts Nos. 911, 912 (1911).] E. H. B.

890. *Gongs and Tom-Toms.* **G. Sizes.** (Comptes Rendus, 154. pp. 504–506, Feb. 19, 1912.)—An account of the partials detected in these instruments. [See Abstract No. 688 (1911).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

891. *Gravitational Force on Electrons.* **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 14. 4. pp. 185–188, Feb. 29, 1912.)—As the evidence to hand points to the mass of an electron being purely electromagnetic, then gravitation must be an electromagnetic phenomenon if electrons are subject to gravitation. This cannot be decided by direct experiment, since gravitation would only equal an excessively feeble electric or magnetic force, and the latter cannot be excluded. But the matter can be decided by pendulum experiments. If the number of electrons is proportional to the atomic weight, equal pendulums with bobs of different materials would have the same periods. If not, then gravitation must act on the electrons, in order to account for the equality of period observed by Bessel (within 2×10^{-5}) and Southerns (5×10^{-6}). The proportionality of electrons to the atomic weight is open to objections on account of the irrational relations between some of the atomic weights. The author therefore inclines to regard gravitation as an electromagnetic phenomenon, propagated with the speed of light, as required by the relativity principle. The author sketches an experiment to discover an influence of gravitation on thermoelectric force, which led to a negative result. E. E. F.

892. *Electronic Charge.* **A. H. Bucherer.** (Ann. d. Physik, 37. 3. pp. 597–598, March 8, 1912.)—Reviews the most recent determinations of e/m_0, which are given as follows:—

Authorities.	$e/m_0 \times 10^{-7}$.
G. Classen, 1908	1·776
A. H. Bucherer, 1908	1·763
K. Wolz, 1909	1·767
J. Malassez, 1911	1·769
E. Bestelmeyer, 1911	1·766

From these and the author's previous work it is concluded that the most recent determinations of e/m_0 form a new and valuable support to the relativity principle. E. H. B.

893. *Periodic Cylindrical Waves in a Conductor.* **Pomey.** (Journ. de Physique, 2. Ser. 5. pp. 203–205, March, 1912.)—The author considers a cylindrical conductor carrying a current parallel to the axis. The intensity of the field Z parallel to the axis of the cylinder is given by—

$$\frac{\partial^2 Z}{\partial r^2} + \frac{1}{r}\frac{\partial Z}{\partial r} - 4\pi c\mu \frac{\partial Z}{\partial t} = 0,$$

where c is the conductivity and μ the permeability. By considering an elementary plane wave $(1/\pi)\partial\phi\epsilon^{i\omega t}\epsilon^{(x\cos\phi + y\sin\phi)/\delta}$ which moves in the direction determined by the angle ϕ, and then integrating it from 0 to ϕ and substituting in the above equation the well-known solution $Z = \epsilon^{ipt}\,\Sigma(r/p)^{2m}(1/m\,!)^2(1/2)^{2m}$ is obtained. Hence we may consider the resultant effect as due to waves proceeding from the axis and crossing one another in all directions. A. R.

894. *Electron Theory of Residual Dielectric Phenomena.* **L. Décombe.** (Journ. de Physique, 2. Ser. 5. pp. 181–196, March, 1912.)—Amongst the residual phenomena discussed the Siemens heat is specially considered. If K denote the dielectric coefficient of a medium and k its dielectric susceptibility $K = 1 + 4\pi k$, and thus $KE/4\pi = E/4\pi + kE = E/4\pi + P$, we see that Maxwell's electric displacement is made up of two parts. $E/4\pi$ is the displacement in the ether, and P is the polarisation which in the electronic theory is localised in the medium. Consider a plate condenser the distance between the plates being unity and their area also unity. In this case the charge q in the condenser equals the total displacement, and the difference between q and the polarisation m equals the displacement in the ether. Hence $q = k_0E + m$, where $k_0 = 1/4\pi$. Following Lorentz we can write—

$$a \, . \, \partial^2 m/\partial t^2 = E - bm - c \, . \, \partial m/\partial t,$$

where a, b, and c are positive coefficients. If the frequencies are decidedly smaller than those of luminous vibrations the term $a\partial^2 m/\partial t^2$ can be neglected. Thus $E = bm + c\partial m/\partial t$. If m_1 be the solution of this equation, and m_2 the solution of $E' = bm + c\partial m/\partial t$, then $m_1 + m_2$ will be the solution of $E + E' = bm + c\partial m/\partial t$, and hence we can use the principle of superposition. The experiments of Höchstädter are discussed, and it is shown that they prove that the displacement in the dielectric lags behind the field; that is, lags behind the displacement in the ether. When a plate condenser is subjected to an e.m.f. $E = f(\omega t)$ the elementary energy absorbed is $E\partial q = E(\partial m + k_0\partial E)$ and the energy W dissipated per period is given by $W = \int_0^T E\partial m = \int_0^T c(\partial m/\partial t)^2\partial t$. The energy dissipated is therefore proportional to the square of the polarisation current. It is proved that the energy W dissipated during a period is independent of the frequency, and is proportional to the lag when the lag is small. It follows also that unless the atom is deformed there will be no Siemens heat or other residual phenomena. These latter phenomena must be due to the viscous nature of the atom. A. R.

895. *Electron Theory of Dielectrics.* **J. Kroó.** (Phys. Zeitschr. 13. pp. 246–249, March 15, 1912.)—Determines the "distribution function" of electrons in a dielectric and deduces a linear dependence of the Clausius-Mossotti fraction $(\epsilon - 1)/(\epsilon + 2)$ upon the temperature. Also deduces Lorentz's equation for the dielectric constant $\epsilon = 1/4\pi + (g/\nu e^2 - 4\pi/3)^{-1}$, where ν is the number of electrons per cm.^{3}, e the electronic charge, and g a function of the molecular displacement. E. E. F.

896. *Motion of Electrified Particle in Magnetic Field.* **R. Birkeland.** (Archives des Sciences, 33. pp. 32–50, Jan., and pp. 151–175, Feb., 1912.)—A mathematical paper dealing with the trajectory of an electrified particle in a magnetic field due to magnets and steady currents. It is shown that, in general, the trajectory of the particle is a geodesic of a surface generated by the lines of force of the magnetic field. The paper is illustrated by a large number of figures showing the trajectories in certain circumstances.

E. H. B.

897. *Law of Molecular Attraction for Electrical Double Points.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 1111–1112, April 25, 1912.)

898. *Physical Application of the Principle of Sufficient Cause.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 14. 7. pp. 879–883, April 15, 1912.)—Considers a charged sphere receiving an impulse producing a uniform velocity and treats the case and the dielectric on the basis of the *theorem of sufficient cause*, endeavouring to draw conclusions therefrom as to the nature of the dielectric. E. H. B.

DISCHARGE AND OSCILLATIONS.

899. *New Method of determining the Velocity of Ions in Flames.* **E. N. da C. Andrade.** (Ann. d. Physik, 37. 2. pp. 380–385, Feb. 20, 1912.)—The various methods previously adopted are briefly considered. The present experiments depend upon the fact that solid particles when introduced into the flame produce clear vertical lines in the latter, and these lines when viewed in a rotating mirror appear to make certain definite angles with the vertical according to the angular velocity of the mirror. From a comparison of the apparent paths as seen in the mirror when it is rotating at different speeds the velocity of the particles can be calculated. It is assumed that the particles take up the velocity of the flame gases. The first series were carried out by means of an ordinary Bunsen burner, particles of coal dust being used to produce the lines. The velocity is found to differ according to the part of the flame examined. In the lower part it is 226 cm./sec., in the middle 257 cm./sec., and at the point of the flame 305 cm./sec. With pressures of more than 1 atmo. it is found that the velocity decreases in a linear manner with increase of pressure, so that when this reaches 4 atmos. it has decreased about 30 per cent. The present method is compared with that of Becker, and it is noted that the results are 1·61 times larger than those obtained by that observer. This can be accounted for by assuming that an incorrect value was given to the constant "*k*" of Becker's formula; this seems most likely to have been the case. A. E. G.

900. *Ionisation in Gaseous Mixtures by Röntgen Radiation.* **C. G. Barkla** and **L. Simons.** (Phil. Mag. 23. pp. 317–333, Feb., 1912.)—It was thought that experiments upon the ionisation produced by Röntgen rays in certain gaseous mixtures would probably throw some light on the processes involved, as the direct and secondary effects can to some extent be distinguished. The radiations used were the homogeneous fluorescent Röntgen radiations emitted by elements when these are exposed to ordinary primary Röntgen radiations. Two ionisation chambers and connected electroscopes were invariably used, each receiving a beam of homogeneous Röntgen radiation from the same sheet of substance placed in the primary beam. One chamber contained air, and was used to standardise the intensity of fluorescent Röntgen radiation from the particular substance used, while the gas in the other chamber was varied to study the relative ionisations in various gases. The experiments have led to the following conclusions:—Ionisation by Röntgen rays is not purely atomic. It depends to a certain extent on the chemical combination of the elements. Equal absorptions of Röntgen rays and of their secondary rays by different gases are not always accompanied by equal ionisations, though as a rule the deviation from proportionality is not great. Equal

absorptions of corpuscular (electronic) radiation by different gases are not always accompanied by equal ionisations. The relative ionisations produced by equal absorptions of Röntgen rays in the gases experimented upon are, within small errors of experiment, the same as those produced by the corpuscular radiation excited by the Röntgen rays. The results thus point to the possibility of the relative ionisations in different gases due to the total absorption of Röntgen radiation being identical with those due to corpuscular (electronic) radiation and α-radiation. Preliminary experiments appear to indicate—though the results must not be taken as conclusive—that much of the ionisation by Röntgen rays is not due to the secondary corpuscular radiation. Further experiments on these lines will probably give the most direct answer to the question as to the part played by secondary rays in the process of ionisation. [See also Abstracts Nos. 830 (1909); 1716, 1747 (1910).] **W. H. Bragg.** (Ibid. pp. 647–650, April, 1912.) A. W.

901. *Becquerel's Photo-voltaic Effect.* **A. Samsonow.** (Zeitschr. wiss. Phot. 11. pp. 33–60, April, 1912. From Inaug. Dissertation, Heidelberg.)—The effect studied is the p.d. between the electrodes immersed in an electrolyte when only one of them is illuminated. This effect was studied in solutions of uranyl sulphate, quinine sulphate, and chlorophyll, the electrodes being translucent films of Pt burnt into plate-glass. The p.d.'s were measured with a Dolezalek binant electrometer. The potential falls on illumination in uranyl and quinine sulphates, and rises in chlorophyll. The curves are best represented by a process of charge combined with diffusion. "Fatigue" is observed, which in uranyl solutions reduces, and in chlorophyll and quinine sulphate reverses the p.d. Uranyl solutions require the presence of traces of uranous salts to show the effect. The yellow pigment in plants is not actino-electric. The max. effect is produced by light of the regions of max. absorption. The photoelectric effect is probably not a consequence, but a precursor of the chemical reactions. Fatigue and after-effects especially show analogies with other light reactions. The absorption of CO_2 by plants is probably due to the production of charges, most likely to separation of electrons in chlorophyll under the action of light. E. E. F.

902. *Photoelectric Fatigue.* **J. Robinson.** (Phil. Mag. 23. pp. 255–268, Feb., 1912.)—Experiments with Zn and Al plates were made to investigate whether there is a true fatigue due to the action of ultra-violet light, and whether such fatigue depends on the electric field. Each electrode was insulated by an amber rod fastened by sealing-wax into a glass vessel, and surrounded by an earthed metal tube with an aperture facing towards a quartz plate, which closed the glass vessel on the side whence the light was admitted. The electrode was allowed to charge itself positively under the action of light from a quartz mercury lamp or an aluminium spark. Its potential at definite intervals was noted, with or without previous illumination. Contrary to the conclusions of H. S. Allen [Abstract No. 262 (1911)] a real fatigue of each metal was found to be produced by ultra-violet light. The fatigue is still discoverable after the lapse of several minutes. The fatigue is only produced when the metal gives off electrons. The electrodes were polished by rubbing with steel, and inserted in the glass vessel, which was pumped out as quickly as possible to a high vacuum. E. E. F.

903. *Photoelectric Properties of Antimonite.* **J. Olie, Jr., and H. R. Kruyt.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 740–743, Feb. 29, 1912.)—Investigates the photoelectric properties of antimonite, discovered by Jaeger [Abstract No. 1899 (1907)]. It is found that Jaeger's conclusion that the sensitiveness to light is bound up with the macrocrystalline structure of the mineral is unfounded. A pure sulphide Sb_2S_3, prepared by heating pure substances to 600° *in vacuo*, shows a conductivity rising on illumination from, say, 100 to 500, even when the sulphide is in the form of rods 1 cm. in diam. In thin sheets the sensitiveness is probably very great, and the fatigue very small. The kind of glass in which the melting is carried out is of great importance. The authors succeeded in melting the native Japanese (Shikoku) antimonite without impairing its sensitiveness. If the loss of S amounts to only 0·5 per cent. a totally inert compound may result. The conductivity was unchanged by melting, but reduced by powdering and compressing. The latter process had, however, no effect on the sensitiveness to light. E. E. F.

904. *Negative Electrons emitted by Heated Metals.* **K. Fredenhagen.** (Deutsch. Phys. Gesell., Verh. 14. 7. pp. 884–897, April 15, 1912.)—When metals are heated to a sufficiently high temperature they emit negative electrons, and the quantity of these increases as the temperature is raised. Richardson has evolved a theory for this effect [see Abstract No. 1489 (1904)] based on the assumption that free electrons, whose velocity conforms to Maxwell's law, are present in the metals, and that at the bounding surface of the metal there is a jump of potential characteristic of that metal. According to this theory, at a given temperature all those electrons escape whose velocity is sufficient to overcome this p.d. The special apparatus for experiments with Na and K is here described, and from the observations made it is concluded that it is extremely difficult to obtain with certainty experimental evidence of the Richardson-effect, all previous measurements having been largely influenced by secondary effects, if not entirely due to them. It is further suggested that it may be possible to trace back the emission of electrons from CaO to a reaction effect. Experiments to test this assumption are in progress. A. E. G.

905. *Transmission of Canal Rays through Gases.* **J. Koenigsberger** and **J. Kutschewski.** (Ann. d. Physik, 37. 2. pp. 161–232, Feb. 20, 1912.)—This paper contains a complete account of the authors' work in this direction, and may be summarised as follows:—Theory shows that only a very small fall of velocity and scattering of the canal rays is produced by collision when that collision is with electrons. Experiments show that the velocity of hydrogen rays remains constant within ± 0·5 per cent. error at pressures to 5×10^{-3} mm. and a free path of 14 cm.: this would be equivalent to a velocity of 1·5 to $2·6 \times 10^8$ cm./sec. The velocity of the dissociated hydrogen rays is equal to that of the positive within a possible error of ± 0·5 per cent. for velocities between $1·5 \times 10^8$ and $2·6 \times 10^8$ cm./sec. The same is true for hydrogen and He rays. It is therefore highly probable that the velocity of the neutral rays is equal to that of the positive within ± 0·5 per cent. The theory of recharging under certain conditions is discussed, on the assumption that the same kind of recharging and absorption occurs for positive and neutral rays alike. This theory is in accord with the general theory propounded by W. Wien. The path of the recharging for a certain value of e/m is a function of the velocity, the pressure, and the molecular weight of the gas, and as such can be shown by a curve and theoretically discussed. Two mathematical explanations for the recharging are formulated. The relation between the numbers of positive

and neutral particles is independent of the pressure in the observation space. It depends upon the velocity, ranging from 0·45 to 0·8 for velocities $1{\cdot}8 \times 10^8$ to $2{\cdot}6 \times 10^8$ cm./sec., and most probably approximates to the value 1 for greater velocities. The free path of the positive ions of equal velocity, and at the same pressure in different gases, is dependent upon the nature of the gas in much about the same way as would correspond to the cross-section of the "rest" molecule. For different canal-ray ions with equal kinetic energy and the same gas pressure the free path (λ_p) is approximately proportional to $1/\sqrt{m}$. The absorption of the essentially positive canal-ray part at pressures of 3×10^{-4} to 5×10^{-3} mm. in the bundle seems to be proportional to the pressure, and quite independent of the velocity for the range considered. On the assumption that in the discharge space the free paths of the positive and neutral particles are equal, the value of the ratio between the observed fall of potential and that calculated from the equation $eE = mv^2$ can be found. For hydrogen rays this value is 2—a result in fairly good agreement with those of W. Wien. The negative ions generally appear when water-vapour is present both in the discharge and observation chambers. By the recharging process neutral ions are formed from negative, and from these neutral ions positive and negative ions are formed by dissociation. The velocity of the negative hydrogen ions which originate in the discharge space is smaller than that of the positive ions. A. E. G.

906. *Counting of Kathode-ray Particles.* **E. Regener.** (Deutsch. Phys. Gesell., Verh. 14. 7. pp. 400–407, April 15, 1912. Le Radium, 9. pp. 150–152, April, 1912.)—A cloud of fine oil drops is produced and freed from charged particles by means of an electric field. The neutral cloud is passed into a chamber into which, from outside, ionising particles can be fired. Thence the oil drops which become charged as a result of the ionisation are drawn by an electric field into the field of view of an ultramicroscope, neutral particles being excluded by a current of air. With α-rays the entrance of an α-particle was signalised by the sudden appearance of a large number of droplets in the field of the microscope—about 700 with the experimental arrangement employed. With slow kathode rays the number was from 10 to 20. Experiments with β-rays have so far not been altogether successful, as owing to their high velocity they produce little ionisation per cm. of path compared with slow kathode particles. Further experiments are in progress. E. M.

907. *Secondary Kathode Rays in Gases in the Vicinity of the best Primary Velocity.* **W. Kossel.** (Ann. d. Physik, 37. 3. pp. 393–424, March 8, 1912.)—A general and complete review of progress in this domain is first given. The present experiments deal only with those secondary rays which are generated by primary electrons of relatively low initial velocity, *i.e.*, the absolute quantity of the secondary rays which are generated by kathode rays of 200–1000 volts velocity in the air and some other gases. The number of secondary electrons liberated by one primary electron along a given path in the same gas, is proportional to the pressure. The largest quantity of secondary rays due to the passage of an electron through 1 cm. of air at 1 mm. pressure is found to be produced when the velocity is 200 volts. Ten secondary electrons are set free under such conditions. The secondary rays in different gases at 1000 volts are compared, and for the gases examined it is shown that with one exception the quantity of secondary rays emitted corresponds to their specific density. The exception is hydrogen, which emits

four times as many electrons as correspond to its weight. It is also probable that pure helium deviates from this general rule, but in a smaller degree and opposite manner to hydrogen. It is found that hydrogen retains its peculiarity in this respect when in combination. The total number of secondary rays liberated by an electron before its absorption, increases with the velocity.
A. E. G.

908. *Light given out by Gases under the Influence of Kathode Rays.* **E. Gehrcke and R. Seeliger.** (Deutsch. Phys. Gesell., Verh. 14. 6. pp. 335–343, March 30, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—It is found that under suitable conditions a bundle of kathode rays show characteristic colour and intensity alterations when their velocity is changed. The velocity is altered by the application of a longitudinal electric field, and a suitable arrangement for investigating the phenomena described is shown. Along one arm of a parabolic-shaped kathode ray it is observed that the colour of the kathode ray in air is blue up to a certain point, then a small portion of the curve at the apex of the parabola is red, then blue again on the other arm. These colour and intensity alterations of the kathode rays depend on the angle under which the rays enter the applied field. In nitrogen they change as in air, only the colours are more intense and also purer. In Ar the change is from blue to deep red, in He from green to golden red, in hydrogen clear blue to rose, in iodine red-violet to golden brown, and in Hg blue-violet to golden white, then deep green. It is suggested that when the rays enter the applied field their velocity is decreased, and as soon as it falls below a certain definite value V_a, the change in colour, which is always to the side of greater wave-lengths, occurs. Should the velocity sink to a still lower value V_β, then the electrons lose the power to light up the gas. The mean values of the results in volts for V_a and V_β are as follows:—

	V_a.	V_β.
Ar	67	85
He..	68	26
H	54	29
N	46	29
Hg	80	10

The connection between these light-changes and the difference of colour between the negative glow and positive column is discussed. A. E. G.

909. *Potential Gradient in Immediate Vicinity of Kathode in the Glow Discharge.* II. **W. H. Westphal.** (Deutsch. Phys. Gesell., Verh. 14. 5. pp. 223–245, March 15, 1912.)—The author has previously shown by measurements with sounds, that in the Crookes' dark space there is in the immediate vicinity of the kathode a jump of potential [see Abstract No. 718 (1910)]. This jump amounts with normal kathode-fall to about 1/4 of the total potential. The present experiments seem to prove the existence of this kathode jump. By the experimental arrangements described the measurements are made without the introduction of sounds which have rendered the earlier results of doubtful value. The method adopted consists in analysis of the form of the path of magnetically-deflected kathode rays. In the cases examined the kathode jump ranges from 0·275 to 0·7 of the discharge potential. The complete accord of these results with those of the author in which sounds were employed seems to indicate that reliable information may be obtained with sufficiently fine sounds. In a note added it is pointed out that the results of Gehrcke and Seeliger [see preceding Abstract], which prove that in air, kathode rays of velocity less than 80 volts lose the power to illuminate the gas, are a further proof of the existence of the kathode jump of potential. The photographs now obtained, in which the rays quite up to the kathode are shown, prove that there must be an initial velocity of at least 80 volts. A. E. G.

910. *Electric Discharge from Points in Gases.* **E. J. Moore.** (Phys. Rev. 34. pp. 81–95, Feb., 1912.)—An experimental research on the reaction effects of the electric discharge from points in gases, the chief results of which may be summarised as follows:—1. The relation between the force of reaction and the distance between point and plane was found to be linear within the range of currents and distances used. The relation between the force and the current for different distances was also found to be linear. 2. The absolute values of the velocities of the ions in unit field were found to be very much higher than those obtained by other methods. The ratio of the velocities was, however, only slightly higher. 3. The variation of the mobility with pressure has been measured from 760 mm. to 5 mm. pressure in air, hydrogen, and CO_2. The mobility of the positive ion was found to be inversely as the pressure down to 5 mm. The negative ion showed a rapid increase in mobility beyond that required by the law $PK =$ constant, beginning at about 20 cm. E. H. B.

911. *Integration of the Electric Equation for Electric Discharge when the Resistance of the Circuit is Variable.* **N. Boulgakov.** (Acad. Sci. St. Pétersbourg, Bull. 7. pp. 507–516, April 15, 1912.)—When the resistance R can be expressed by an equation of the form $R = r + R_0(1 - at)^{-1}$, where t denotes the time, the author shows how a solution can be obtained. As any given curve can be supposed to be made up of elementary lines a method of getting the complete solution is indicated. Numerical examples will be given in a further paper. A. R.

912. *Alternating Discharge in Gases.* **L. Amaduzzi.** (Accad. Lincei, Atti, 21. pp. 40–41, Jan. 7, 1912.)—The alternating discharge is produced by an alternating voltage obeying a pure sine curve. The pressure is from 10 to 15 mm. of Hg. The luminous discharge consists of ovoid patches separated by nearly dark intervals and flanked by tufts at both electrodes. The range of pressure within which the phenomena appears depends upon the shape and distance of the electrodes and the nature of the gas. The number of patches diminishes with the pressure, and also on increasing the inductance in the primary transformer circuit. E. E. F.

913. *New Researches on Electrical Discharges.* **L. Amaduzzi.** (N. Cimento, 3. pp. 51–65, Jan., 1912.)—A continuation of the author's investigation of the electrical discharge between two charged bodies [Abstract No. 578 (1905)], the variation of explosive potential with the distance between the two bodies, and the appearance of the discharge under reduced pressure being studied. The explosive potential rises fairly regularly with increase in the distance between the bodies, from 7000 volts for 1·5 cm. to 97,000 volts for 13·5 cm., and more than 100,000 volts for 14 cm. The variation in appearance of the discharge for different distances between the electrodes is in general very similar for all pressures between 1 atmo. and about 45 mm., but a dis-

charge with reddish glow only occurs with increasing distance between the electrodes as the pressure is reduced, viz., at a distance of 20 mm. for 440 mm. pressure, 45 mm. for 290 mm., and 70 mm. for 210 mm. pressure. W. H. Si.

914. *Distribution of Potential in the Dark Space.* **K. Eisenmann.** (Deutsch. Phys. Gesell., Verh. 14. 6. pp. 297–314, March 30, 1912. Extract of Dissertation, Berlin, Aug., 1910.)—After a description of the apparatus used and the measurements made a theory relative to the phenomena is given. The alteration of free electricity in the dark space, and also the alteration of quantity of free electricity with current and pressure is discussed. The following conclusions are arrived at: When the space is of sufficient magnitude the quantity of free electricity is dependent only on the potential gradient at the surface. It is positive and its value $1/4\pi\,(dv/dr)_0$ per cm.² of kathode surface is independent of the form of the kathode. When the current is sufficiently large and the pressure not too low the free electricity is independent of both current and pressure, but it is found that at low pressures it diminishes quickly. This last point is in agreement with the observations of Wehnelt. The curves which show the dependence upon current, taken collectively indicate an equation for a hyperbolic curve the origin of which is at a point $C = 142$ volts. The asymptotes of this hyperbola, for which the distance from the kathode is equal to the total size of the dark space, are the Skinner lines. The equation for the hyperbola is $V_x = C + cR\sqrt{i\,(i + 2a_x)}$, while that for the asymptotes is $V_x = C + cR\,(1 + a_x)$. The dependence of the potential on x is for plane kathodes indicated by $V = a\,(1 - \beta e^{-kx})$. The dark space contains only free positive electricity. The potential-distribution curves collectively indicate that they can be traced back to a single curve of origin. The jump at the kathode surface increases in a linear manner with the current and free path in the gas. A. E. G.

915. *Relation between Current, Voltage, Pressure, and the Length of the Dark Space in Different Gases.* **F. W. Aston** and **H. E. Watson.** (Roy. Soc., Proc. Ser. A. 86. pp. 168–180, Feb. 20, 1912.)—Aston has previously carried out experiments along similar lines for hydrogen, nitrogen, oxygen, and air [see Abstract No. 1072 (1907)]. The first part of the present paper consists of a continuation of the work giving results obtained with CO, Ar, and He, together with some constants for these and the gases previously mentioned which were not published at the time. The second part deals with a systematic investigation of the behaviour of the inactive gases when in a state of great purity. The apparatus used is such that a discharge takes place between Al discs 10 cm. in diam. and about 17 cm. apart, the kathode being of the guard-ring type to ensure accurate measurements of the current density. Full details of experimental arrangements with pure inert gases are given. The case of CO is of particular interest as it is the only compound gas yet experimented on which allows the passage of a continuous current without any very serious decomposition. In its behaviour it resembles the active elementary gases. It is found that the gases of the He group are very similar to one another in their manner of conducting the discharge, but at the same time they differ considerably from the active gases in that the equations: $D = A/P + B/\sqrt{C}$, $V = E + F\sqrt{C}/P$, in which A, B, E, and F are constants, P is pressure in 1/100ths of a mm., C is current density in tenths of a milliamp. per cm.² of kathode, D is the dark space in cm., do not hold any degree of accuracy. The first is true for high values of C, but the second appears in no way applicable. One feature common to gases of the group is that they all exhibit the primary dark space close to the kathode. The relation between V and $\sqrt{C}$ at constant pressure tends to deviate from the linear type and become hyperbolic, the curve rising fairly steeply at first and then turning over and becoming nearly horizontal. Apart from small individual peculiarities, the behaviour of each of the five inactive gases is very much of the same nature, provided the experiments are conducted at constant pressure. Thus, the $1/\sqrt{C}$, D, curves are almost identical, and the V, $\sqrt{C}$, curves are similar. The only marked difference in making the experiments is that the range of pressures over which they can be carried out in order to obtain similar values for the length of the dark space and the voltage, is widely different, varying regularly from 1·5–0·2 mm. in the case of helium to 0·3–0·06 mm. in the case of xenon. A table showing the constants of the above formulæ for the inert gases as compared with oxygen is given, and their peculiarities and similarities are discussed. Owing to insufficient data there is no theoretical discussion of the general results. Further experiments with kathodes of different shapes are in progress. A. E. G.

916. *Anode Dark Space in the Discharge in Oxygen.* **F. W. Aston** (Nature, 89. p. 218, May 2, 1912.)—Unmistakable evidence has recently been obtained of an anode dark space in the discharge in oxygen at low pressures. The anode in this case was an Al plate which had been used as anode during an extended series of measurements of the Crookes' dark space with kathodes of different metals. These were continued for some months, and the phenomenon was not noticed when the anode was fresh, hence it appears that there is some connection between the occurrence and the excessive fatigue of the metal surface. The anode dark space is a region of comparative darkness just in front of the anode, and can only be seen when the latter is immersed in the bright negative glow. Its thickness is small, but as its edge is exceedingly sharp it can be measured with fair accuracy. The values already obtained, though rough, show it to be entirely unaffected by changes of pressure and to vary inversely as the square root of the current density. With the latter at 1/10 milliamp. per cm.^{2} its value is about 1·2 mm. in pure oxygen. The same anode shows it, though faintly, in air and nitrogen, but no trace of it can be observed in hydrogen. A. E. G.

917. *Current-potential Curve for Uniformly Ionised Air.* **H. Greinacher.** (Ann. d. Physik, 37. 3. pp. 561–568, March 8, 1912.)—The paper deals with mathematical expressions for the relation between observed current, saturation current, and potential for air between two parallel plates. The author discusses the formulæ of J. J. Thomson, Mie, and Seeliger, and the experimental results of Seeman which have been found to agree very well with the theoretical expressions. The formula is derived $i/J = 1 - e^{-v/Jw}$, where i is the ionisation current and J the saturation current. E. M.

918. *Propagation of Long Electric Waves during the Solar Eclipse.* **W. H. Eccles.** (Nature, 89. pp. 191–192, April 25, 1912.)

919. *Diffraction of Hertzian Waves.* **H. Poincaré.** (Comptes Rendus, 154. pp. 795–797, March 25, 1912.)—A criticism of a paper by March [see Abstract No. 569 (1912)]. The paper is mathematical and indicates how March's results differ from those of Poincaré. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

920. *Crystallisation of Selenium Plates.* **W. S. Gripenberg.** (Phys. Zeitschr. 13. p. 161, Feb. 15, 1912.)—Correcting a previous communication [Abstract No. 622 (1910)], the author announces that Se crystallises normally down to thicknesses of 0·1 μ between glass plates. Crystalline Se is translucent under 0·55 μ thickness, the colour being deep red, but with a more violet tinge than amorphous Se. Wedges of Se tapering from 1 μ down to 0·03 μ show a continuous transition from black to deep red, bright red and bright purple. The wedges show conductivity, sensitiveness to light, and very slight inertia. The effect of quinoline on amorphous Se was studied. A plate 1 μ thick was completely crystallised in 24 hours, but it was then no longer coherent, but broken up into isolated pieces about 0·05 mm. in diam. Crystallisation begins at several points simultaneously and proceeds very slowly. The method is at present inapplicable to the construction of selenium bridges. E. E. F.

921. *Photophones with Potassium Cells.* **E. Bloch.** (Comptes Rendus, 154. pp. 427–428, Feb. 12, 1912.)—Proposes, after Bergwitz [Abstract No. 1384 (1907)] to use photoelectric cells with alkali metals for the electrical transmission of luminous vibrations. The negative pole of a battery of a few hundred volts is connected to the potassium in an exhausted bulb, and the positive pole through a telephone and milliammeter with a wire above the potassium. The arc gives a current of 100 to 200 microamps. and sunlight 500 microamps. A rapidly interrupted beam gives a current corresponding to the mean illumination, and independent of the rate of interruption. The telephone emits a loud sound whose pitch corresponds to the speed of rotation of the interrupting disc. The pitch may be as much as 2000, showing that the photoelectric current varies with the light in 1/2000th sec. The effect could be increased by replacing the potassium by rubidium, and the glass by fused silica. E. E. F.

922. *Heating Effect of Electric Currents in Measurements of Resistance.* **H. T. Barnes.** (Roy. Soc., Proc. Ser. A. 86. pp. 330–332, March 26, 1912.)—A description of certain experiments made to determine the increase of resistance of some platinum-silver wires due to the rise of temperature with the passage of a current through them. It is concluded that in the author's experiments on the specific heat of water the error due to the superheating of the platinum-silver resistances was probably less than 1 part in 10,000 and therefore considerably less than the estimate given by Glazebrook, Bousfield, and Smith [see Abstract No. 73 (1912).] F. E. S.

923. *Change of Electrical Resistance of Tin on Fusion.* **P. Cermak.** (Deutsch. Phys. Gesell., Verh. 14. 7. pp. 414–418, April 15, 1912.)—The author has carried out experiments on the sudden change of conductivity of tin on melting, to see whether the change was in any way influenced by the varied adsorption of gases in the solid and liquid states. Experiments were carried out in hydrogen gas, with the pressure atmospheric, and also with the highest possible vacuum. The change in resistance at the melting-point remained unaltered. A. D. R.

924. *Dielectric Constants of Dissolved Salts.* Part I. **P. Walden.** (Acad. Sci. St. Pétersbourg, Bull. 4. pp. 305–332, March 1, 1912.)—Whilst in good

ionising solvents, such as water and formamide, all the substituted ammonium salts are good conductors, a marked contrast exists in solvents of weak ionising properties, such as SO_2, when the tetra-alkyl compounds are found to be strongly dissociated with a progressive decrease to the feebly-dissociated mono-alkyl salts. The question is raised as to what physical property decides the different behaviour of salts of precisely the same general type, and the suggestion is made that the specific inductive capacity of the solute may be almost as important as that of the solvent on the Nernst-Thomson hypothesis. Measurements made hitherto to determine the dielectric constants of salts in solution have failed because only a trace of salt can be added to water before the increased conductivity makes it impossible to measure the constant. By using chloroform (S.I.C. 4·95) as solvent, and substituted ammonium salts as solutes, this difficulty has been so far overcome as to enable the author to prove that the salts (and especially the tetra-substituted salts) have a specific inductive capacity vastly higher than the solvent. The actual values for the salts are very uncertain as different figures are given by the various formulæ used to express the S.I.C. of mixtures, but in the case of the salt $N(C_2H_5)_4Cl$ in N/10 solution the figures 900, 192 and 140, all show an extraordinarily high value for the salt. This is in accord with the fact that solid salts give abnormally high values (up to 80) and must give still more remarkable figures if they showed the same increase on fusion that is noticed in the case of insulators. The high S.I.C. of dissolved salts affords an obviously possible explanation of the deviations from Ostwald's dilution law in the case of strong electrolytes. T. M. L.

925. *Contact E.M.F. and Thermo-electricity.* **O. W. Richardson.** (Phil. Mag. 23. pp. 263–278, Feb., 1912.)—An electron theory of contact e.m.f. is based upon two assumptions: (*a*) That the electric current in metals is carried by electrons which move about freely, exert a pressure, and are otherwise dynamically equivalent to the molecules of a gas; (*b*) that the potential energy of an electron is much less when it is inside an uncharged conductor than when it is extracted and removed to a considerable distance, a definite amount of work w being done in crossing the surface. Considerable use is made of the theorem that in any system in equilibrium at a constant temperature θ, if n_1 is the concentration of electrons at a point A and n_2 that at a point B, then $n_2/n_1 = \epsilon^{-W/R\theta}$, where W is the work done in taking an electron from A to B and R is the gas constant reckoned for a single electron. If A and B are two different conductors for which w is different, the steady difference of potential for two conductors in an enclosed space is $(1/\epsilon)[w_1 - w_2 + R\theta \log (n_2/n_1)]$, and the Peltier-effect is $R\theta/\epsilon \,.\, \log (n_1/n_2)$. By an ideal thermoelectric cycle, the author shows that the last expression represents the real heating effect due to the passage of an electric current across the junction of two dissimilar metals. E. E. F.

926. *Metallic Disintegration by Ultra-violet Light.* **F. Schulze.** (Deutsch. Phys. Gesell., Verh. 14. 5. pp. 246–257, March 15, 1912.)—The alleged disintegration of metals by ultra-violet light was tested for by three methods: (*a*) by increased transparency of gold-leaf after the radiation; (*b*) investigation of the radio-activity of an electrode mounted opposite a polonium preparation exposed to ultra-violet light; (*c*) measurement of the electric resistance of films of Ag, Pt, and Au before and after illumination by ultra-violet light. All three methods gave a negative result. If disintegration takes place, it is much less than has been supposed. E. E. F.

927. *Application of Fresnel's Polygon to the Composition of Electromotive Forces.* **A. Guillet.** (Journ. de Physique, 2. Ser. 5. pp. 205–218, March, 1912.)—It is shown how e.m.f.'s can be compounded simply by means of Fresnel's polygon. The formulæ for the e.m.f. generated in all kinds of windings can be written down quite simply without the necessity of using the formulæ for the summation of sines of angles which are in arithmetical progression. Undulatory, rectified, and polyphase waves can be treated in a similar way. A. R.

928. *Measurements in Radio-activity.* **J. v. Weszelszky.** (Phys. Zeitschr. 13. pp. 240–246, March 15, 1912.)—The author gives a detailed account of an electroscope for measuring the activity of radium emanation and also of any source of α-rays. The construction of the apparatus is not new in principle but various devices are described which render measurements very accurate. Details are given of methods for transferring emanation from solutions, such as water from springs, to the testing vessel without loss and also for carrying out tests. E. M.

929. *Universal Electrometer for High and Low Potentials.* **A. Pizzarello.** (N. Cimento, 3. pp. 30–40, Jan., 1912.)—The author shows how, by means of a series of condensers of different capacities, or by the use of two twin spheres, the Exner electrometer can be employed for measuring any potential, however large or small. Celluloid discs of various diams. are employed to form the condensers, the diam. of the copper plate being kept constant at 15 cm. With discs of 3·3, 5·5, 8·3, and 13 cm. diam. the condensing power of the condensers is 5, 10, 20, and between 40 and 45 respectively. [See also Dieckmann, Abstract No. 749 (1912).] W. H. Sl.

930. *Self-induction and Capacity Measurements.* **E. Orlich, W. Peukert,** and **H. Zipp.** (Elektrotechn. Zeitschr. 33. p. 332, March 28, 1912.)—Two letters pointing out that an error occurs in Zipp's article on the measurement of inductances [see Abstract No. 586 (1912)], together with Zipp's reply. F. E. S.

931. *Electromotive Force of Weston Normal Cell by Haga and Boerema.* **de Baillehache.** (Journ. de Physique, 2. Ser. 5. pp. 112–120, Feb., 1912.)—[See Abstract No. 273 (1911).] F. E. S.

932. *Quadrant Electrometer.* **A. Anderson.** (Phil. Mag. 23. pp. 380–385, March, 1912.)—A mathematical theory of the behaviour of this instrument. [See Abstracts Nos. 1152 (1904) and 1190 (1911).] E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

933. *Anomalous Magnetisation of Iron and Steel.* **B. O. Peirce.** (Amer. Acad., Proc. 47. No. 17. pp. 633–670, March, 1912.)—Von Waltenhofen described, in 1863, cases of anomalous magnetisation, that is, cases in which, when the magnetising current was stopped, a thick iron cylinder had remanent magnetism of the opposite polarity from that of the temporary magnetism. Righi in 1880 described similar effects, and G. Wiedemann explained them as due to eddy currents in the iron accompanying surges in the exciting current. The present paper describes experiments made for the purpose of determining the conditions under which anomalous

magnetisation appears. Almost every piece of iron is more or less strongly magnetised when it comes into the hands of the observer, and it is often very difficult, if not impossible, to demagnetise a massive block thoroughly. Methods of demagnetising by reversals are recounted, and it is remarked that in practice the method of heating the iron to a white heat and cooling in zero field often fails to demagnetise completely. The first series of curves given for short thick bars of iron and steel, exhibits normal remanent magnetism when the magnetising field is withdrawn gradually, but abnormal or reversed magnetism when the field is withdrawn suddenly. So far as could be ascertained, oscillations were always present in the circuit of the exciting current when anomalous magnetisation was afterwards detected in the core. When packages of short iron wire were used, no cases of anomalous magnetisation were observed. A considerable number of additional experiments are described, and the general results seem to lend support to the theory that the residual moment of an originally neutral bar, which has been magnetised in a solenoid, is always normal unless the current, on its way to extinction, oscillates to and fro. When the exciting current is destroyed without oscillation, even though the process is finished in a small fraction of a second, the remanent magnetism has the same sign as that of the magnetising field. G. E. A.

934. *Magnetic Skin Effect in High-frequency Fields.* **H. Zahn.** (Ann. d. Physik, 37. 2. pp. 330–350, Feb. 20, 1912.)—Describes a method of determining the magnetic flux through metallic plates giving a pseudo-Hall effect when traversed by an alternating current in a magnetic field [see Abstract No. 78 (1912)]. Shows that the method is capable of considerable accuracy, and that the measurement of the total flux and its distribution over the plates leads to values approximately agreeing with theory. E. E. F.

935. *Hysteresis of Iron under Electrical Oscillations.* **H. Fassbender** and **E. Hupka.** (Deutsch. Phys. Gesell., Verh. 14. 7. pp. 408–418, April 15, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Hysteresis curves for iron under alternating currents of low frequency can be obtained by oscillograph methods from the calculated values of μ', defined as B'/H', where B' is the max. induction during the course of a period, and H' is the corresponding field intensity. The author has determined μ' for iron under oscillations of high frequency. In his experiments the iron forms the core of a coil through which the electrical oscillations flow, and the B-H diagram can be built up from the instantaneous values of the field intensity in the iron and the corresponding instantaneous values of the induction. The course of the field intensity is made of sine form, and its amplitude is given by the effective value of the current. The variation of induction is determined from the p.d. at the terminals of the coil as measured by a Braun tube, and the amplitude can be calculated from the electrically measured value of the p.d. Details are given of the apparatus and also some results. A. D. R.

936. *Magnetisation in Iron in Two Fields at Right Angles.* **G. Vallauri.** (N. Cimento, 3. pp. 233–238, March, 1912.)—The paper is a discussion of certain points in a work on this subject by G. Ercolini [see Abstract No. 1227 (1911)]. It is shown that the difference in the effect of the transverse field upon the longitudinal magnetisation according to the phase in which it is applied, may be studied by drawing a polar diagram for the magnetisation and field, in which the effect of applying the increase in transverse field at different points of the cycle becomes evident. For a given longitudinal field the effect of the transverse field depends upon whether the magnetisation is upon the ascending or descending limb of the cycle, the difference diminishing as the transverse field increases, reaching a unique point for very high transverse fields. The experimental results of Ercolini, including the dependence upon the relative phases of the longitudinal and transverse fields, are therefore explained. S. G. S.

937. *Wiedemann-effect in Silicon Steel.* **T. Gnesotto and S. Breda.** (N. Cimento, 3. pp. 5–29, Jan., 1912.)—The authors have studied the Wiedemann torsion of a wire of silicon steel, 0·17 mm. in diam., and 35 mm. long, when suspended vertically in a longitudinal field varying continuously between equal positive and negative values, and the current traversing the wire being maintained constant. Diagrams are given showing that the cycle soon acquires a definite form, and for small values of H, is similar to that for magnetisation of the steel, but that as H varies between wider limits, the positive torsion increases with the field to a maximum and then decreases, the return path for the torsion as H decreases rising to a higher maximum for a higher value of H, and then rapidly falling away, its curve intersecting that for the rising field. W. H. St.

938. *Magnetic Examination of the Function of the Water Molecule in Dilute Solutions.* **A. E. Oxley.** (Cambridge Phil. Soc., Proc. 16. No. 5. pp. 421–427, March 7, 1912.)—According to the modern hydrate theory of solutions, as developed by H. C. Jones from considerations based on conductivity and lowering of the freezing-point determinations, the total amount of water associated with the solute increases with the concentration, and further, the number of water molecules associated with one molecule of the solute increases with the dilution. This has been shown to be true for a large number of salts. Consideration of the solution of a salt of a ferromagnetic element in water in the light of this theory leads to the conclusion that in dilute solutions an abnormal decrease in the paramagnetic susceptibility might be expected. The susceptibilities of a series of dilute solutions of several salts have been determined in order to ascertain if such a reduction in paramagnetism takes place. It was found that the complex hydrates, whose existence is indicated by conductivity and lowering of the freezing-point determinations, cannot be detected by their effect on the magnetic property of the solute. This is what may be expected if the hydrates themselves are unstable enough. The nucleal salt molecule or ion rotates independently of the condensed shell of water molecules on the application of the magnetic field. In the case of cobalt chloride there appears to be a definite chemical hydrate in solution, part or all of whose combined water can be removed by a strongly dehydrating agent. The solution so dehydrated has a max. increase in paramagnetic susceptibility amounting to 3 per cent. A. W.

939. *Magnetic Observations during Solar Eclipse, April* 28, 1911. **O. H. Tittmann.** (Terrestrial Magnetism, 17. pp. 21–30, March, 1912.)—In addition to the usual magnetograph records the observers in charge of the magnetic observatories of the Coast and Geodetic Survey made declination observations every 15 minutes for a period of 6 hours including the eclipse. Temperature variation could be neglected as the instrument rooms are all so well insulated that the daily variation is seldom greater than 0·2° or 0·3° C.

Tables are given for the magnetic elements at intervals of 5 minutes as determined from the photographic records; also for the normal diurnal variation determined from selected quiet days. C. P. B.

RADIOLOGY AND ELECTROPHYSIOLOGY.

940. *The Milliammeter and the Intensity of Röntgen Rays.* W. Salomonson. (Archives d'Él. Médicale, 20. pp. 296–303, April 10, 1912.)—If the current is due to electrons carrying a definite charge, on the current being known the number of electrons can be calculated. The collision of these electrons with the antikathode produce Röntgen rays, and if one electron produces one ray the quantity of rays generated is likewise known. According to this the readings of the meter indicate the intensity of the Röntgen rays. Arguments are given to prove that positive rays also participate in the passage of the current, and therefore the latter cannot be considered as due to electrons only, and further, the auxiliary anode plays some part in the flow of electricity. Even in the case of those electrons emitted by the kathode which reach the antikathode it does not follow that each gives birth to an equal quantity of Röntgen rays of the same hardness. Blythswood and Scoble came to the conclusion that the milliammeter does not give exact measurements of the intensity of the rays. In the present experiments different parts of a photographic plate are exposed to the action of rays of widely differing degrees of intensity. The length of exposure is also varied, the number of milliamp.-seconds being kept constant. As the result it is found that the number of interruptions per sec., and perhaps also the form of the curve have an important influence on the indications of the meter. In all cases they tend to prove that no reliance can be placed on the readings of the meter so far as the exact quantity of the rays is concerned. It is only under certain definite conditions in which the same apparatus is made use of and the number of interruptions kept constant that the indications of the meter can safely be used, and then only if the intensity remains between 1 and 3 milliamps. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

941. *Time-course of the Absorption of Gases by Wood Charcoal.* **F. Bergter.** (Ann. d. Physik, 37. 3. pp. 472–510, March 8, 1912.)—Having first found (*a*) that a temperature of 550° is sufficient to heat cocoanut charcoal to, in order that it may be used for successive measurements, and (*b*) that powdering the charcoal to an impalpable powder has, with the exception of the first few minutes, no considerable influence on the course of gas absorption, the author measured the rate of absorption of air at pressures between 785·6 and 4·52 mm. For pressures above 19·58 mm. the results are given by the equation: $m = m_1t/(a + t) + m_2t/(b + t)$, where m is the mass absorbed at the time t, and m_1, m_2, a and b are constants. In the case of nitrogen, for pressures between 9·66 and 0·385 mm. the results are given by the expression: $m' = m_0(1 - 0{\cdot}95e^{-3\cdot5t} - 0{\cdot}05e^{-0\cdot15t})$. In the case of oxygen, only the relation between the amount absorbed and the pressure was determined between the pressures 5·795 and 0·681 mm., and not the rate of the absorption. The ratio in which two different gases are absorbed by the charcoal depends on the pressure. At pressures of 0·5–10 mm., pure oxygen is absorbed by cocoanut charcoal 30–40 times as strongly as pure nitrogen. The presence of oxygen increases the absorptive power of the charcoal for nitrogen. T. S. P.

942. *Sublimation, Evaporation, and Melting of Monatomic Elements.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 14. 6. pp. 322–334, March 30, 1912.)—On the basis of Mie's theory [Abstract No. 1450 (1904)] some conclusions are drawn and tested with regard to changes of state. The heat of sublimation at absolute zero is represented by $A/v_0 - B/v_0^m$, where A and B are constants, v_0 is the atomic volume at zero, and m is a number approximating to 4. Further $B = 1/mAv_0^{m-1}$. The heat of sublimation is also $= 1/m \,.\, v_0/\kappa_0$, where κ is the compressibility. The heats of sublimation thus calculated range from 50 kg.-cals. in the case of Mg to 187 in the case of Pt. To carbon the provisional value 280 is assigned. The heat of evaporation may be calculated by deducting from the sublimation heat at zero the heat of melting, and also the quantity $\frac{1}{2}RT^\sigma$, where T_σ is the boiling-point at 1 atmo. In carbon and iron, however, intermediate thermal changes must also be taken into account. A table of calculated and observed vapour pressures is given. As regards melting-points, it is found that the relative change of volume on melting is of the same order for all monatomic elements, and lies between 0·03 and 0·05. E. E. F.

943. *The Proper Frequencies of Elements in Compounds.* **F. Koref.** (Phys. Zeitschr. 13. pp. 183–188, March 1, 1912.)—If we regard the melting-point as that temperature at which the amplitudes of atomic oscillation become so large that the atoms of neighbouring molecules touch, the change of melting-point referred to that of the free element is a measure of the change of frequency, when the change of volume (generally small) is neglected. The author on this assumption obtains a modification of Lindemann's formula, for the frequency of the atom in a compound, viz., $\nu' = 2{\cdot}80 \times 10^{12}\sqrt{(T_s/AV'^{2/3})}$, where T is the melting-point of the compound

and V' is the volume of the atom in the molecule. On account of the additivity of atomic volumes, V' can, as a first approximation be put equal to V, the atomic volume of the free element. Knowing the value of the frequency, we can calculate from the melting-point the atomic heat of an element according to the formula of Nernst and Lindemann [Abstract No. 507 (1912)]. The frequency of an atom in a compound can therefore be calculated from the melting-point of the compound, the atomic weight and atomic volume of the element, and the molecular volume of the compound. Since the frequency of the free elements is known in many cases from measurements of the atomic heat, the change in frequency can be calculated from the equation—$\nu'/\nu = \sqrt{(T'_s/T_s)}\sqrt{(V/V')}$. If the molecular volume is put equal to the sum of the atomic values, $V' = V$, and therefore $\nu'/\nu = \sqrt{(T'_s/T_s)}$. By means of this formula the author has calculated the proper frequencies for a number of compounds, and found values which agree well with those determined. The author also points out that the calculation of chemical affinity of solid substances is possible according to the Nernst theorem of heat, if the heat effect of the process and the melting-points and density of the participating molecules are known. A. F.

944. *Statistical Theory of the Solid State.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 983–991, March 28, 1912.)—A theory of monatomic solids may be based upon the statistical considerations of Boltzmann, as done by Mie [Abstract No. 1450 (1904)] by the virial method. The same results may be reached in a somewhat simpler manner by the theory of canonical ensembles. The author modifies this theory by taking Planck's hypothesis into account. We are then no longer allowed to suppose without further proof that the statistical free energy is identical with thermodynamic free energy, because for the proof of the identity of these quantities we make use of the supposition that the systems of nature are mechanical in the sense of being controlled by Hamilton's equations, which cannot be the case for the systems for which Planck's hypothesis holds. In this paper it is supposed that all the arguments applicable to Gibbs's ensembles also apply to the modified ensembles. The author finds that Nernst's heat theorem holds for these systems of atoms capable of oscillations about positions making up, say, a cubical network. The statistical free energy may be derived in a similar way on Sommerfeld's hypotheses. E. E. F.

945. *Structure of Ternary Alloys.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 32. pp. 36–39, 1911–1912.)—The purpose of this note is to call attention to the structural arrangement of a binary eutectic in a ternary alloy. During the cooling of an alloy of three metals, the primary crystals solidify under conditions similar to those in an alloy of two metals, the ternary eutectic also freezes at constant temperature like the binary eutectic of a binary alloy, but, during the solidification of the binary eutectic in a ternary alloy, the temperature is not constant and a portion of the mass is always liquid. The particles of the binary eutectic are therefore free to migrate unless the rate of cooling is very rapid, and instead of the fine structure usually associated with eutectics, the crystals of each of the two phases are able to grow to a considerable size and have exactly the same appearance as primary crystals. C. O. B.

946. *The Iron-Carbon System.* **W. C. McC. Lewis.** (Zeitschr. Elektrochem. 18. pp. 158–159, March 1, 1912.)—Using the values for the solubility of carbon in iron in the solid and liquid states extrapolated from Carpenter and Keeling's diagram, the author has calculated the molecular weight of the dissolved carbon from the well-known freezing-point depression equation. The results show that the most probable value for the latent heat of iron is 80 cals., and that the carbon exists in the monatomic state as the carbide Fe_nC, which is most likely Fe_3C. F. C. A. H. L.

947. *The Production of Sound Steel.* **R. A. Hadfield.** (Mech. Eng. 29. pp. 242–243, Feb. 23, 1912. From "The Iron Age.")—The author points out the necessity of producing sound steel; that is, steel free from segregation, blowholes, and piping. As a rule, the remedy which obviates or overcomes any one of these difficulties tends to improve all. After enumerating some of the methods which have been suggested and tried for obtaining sound ingots, a description is given of the Hadfield method of casting steel ingots, making castings, &c., ensuring soundness, freedom from piping, and absence of segregation. The method consists of heating the metal in the upper part of an ingot, or other mould, and maintaining it in a liquid condition by the combustion of solid fuel (for example, charcoal) during the cooling and shrinkage of the metal in the lower part of the mould. The combustion is carried on by means of a blast of air, and a layer of fusible material, such as iron slag, which has no injurious action on the metal, is interposed between the metal and the fuel. During the last few years many thousands of tons of ingots have been made by this patented process, the cost of which is trifling compared with the large saving gained by reducing loss and waste of material. Illustrations are given of the method of carrying out the process. The results of tests given show losses by scrap and waste of 7·9 and 8·8 per cent., and it is estimated that on a large output the saving by this method would be 8s. to 12s. per ton. C. O. B.

948. *Electric Smelting of Zinc Ores.* **W. Borchers.** (Metallurgie, 9. pp. 153–154, March 8, 1912.)—Sulphidic and oxidic zinc ores can be smelted with metallic iron according to $ZnS + Fe = FeS + Zn$. The iron monosulphide conducts the current and dissolves both blende and oxide, and also the iron, and the zinc is volatilised at about 1300° C. The blende need not be roasted, but the materials must be finely divided. **Eulenstein** (Ibid. pp. 154–158) has studied the solubility of iron in the iron sulphide, and **F. Thomas** the smelting of zinc oxide in a silicate slag. [See next Abstract.] H. B.

949. *Electric Resistance Furnace for any Bath-length.* **F. Thomas.** (Metallurgie, 9. pp. 158–160, March 8, 1912.)—The cylindrical furnace is built up of rings of bricks, each ring being surrounded by a water-jacket; the electrode carbons are fitted into the ends of the cylinder. When the length is to be altered a ring is taken out or added. The furnace can also be made tilting. Briquettes of zinc oxide and coal and pitch are fed into the molten silicate slag; these briquettes float on the slag, and the distillation of zinc would be more rapid if the briquettes would sink. H. B.

950. *The Energy-change in Photochemical Processes in Gases.* II. **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Ber. 12. pp. 216–225, 1912.)—In continuation of previous work [Abstract No. 1628 (1911)], the author has determined the photochemical yield in the formation of ozone in oxygen under a pressure of 100–150 kg./cm.^{2}, and for light of wave-length 0·208–0·214, to be, in round numbers, 46 per cent. This value is found also to be in good agreement with the theorem of Einstein. A. F.

951. *The Methane Equilibrium.* **J. N. Pring and D. M. Fairlie.** (Chem. Soc., Journ. 101. pp. 91–108, Jan., 1912.)—The experiments [see Abstract No. 108 (1912)] have been continued with a Hutton-Petavel pressure furnace. The electrically-heated retort carbon rod had usually a length of 10 cm. and a diam. of 8 mm., and was electrolytically coated with a catalyst (Pt or Pd). The reaction between carbon and hydrogen, resulting in the formation of CH_4, proceeds with increased velocity as the pressure is increased. Equilibrium was reached in 2 hours at 1200° or 1300° C., and from 30 to 50 atmos., and in 15 min. above 1400° C.; at 200 atmos. the reaction was still more rapid. It is hence probable that at still higher pressures the finely-divided carbon would combine with hydrogen with extreme rapidity. No saturated hydrocarbon, except CH_4, is formed up to 2100° and 200 atmos.; traces of acetylene were observed at a temperature as low as 1275° (and 100 atmos.); between 1800 and 2100° the pressure did not exert any influence on the comparative yields of acetylene and ethylene. The relative amount of methane produced increases with the pressure in accordance with the law of mass action and the reaction $C+2H_2=CH_4$; the value $(p-CH_4)/(p-(H_2)^2)$ should therefore be constant at all temperatures. As regards the amounts of methane which are in equilibrium with hydrogen and carbon, amorphous carbon gave less definite values than graphite, owing to the gradual transformation of amorphous carbon into graphite. It is shown that the change of free energy in the transformation of carbon into graphite increases rapidly between 1200° and 1600°, and it would follow from Kirchhoff's law (heats of reaction and specific heats) that the mean specific heat of amorphous carbon must be much higher than that of graphite between 0 and 1200°, and that the difference increases with the temperature. The assumed specific heats could be corrected with the aid of the equilibrium constants. H. B.

952. *Combustion of Carbon Monoxide.* **H. Wieland.** (Ber. Deut. Chem. Gesell. 45. pp. 679–685, 1912.)—The author finds that carbon monoxide is oxidised to carbon dioxide by palladium-black in the presence of water, the reaction taking place readily in the cold and in the absence of oxygen, according to the scheme: $CO + H_2O \longrightarrow CO_2 + H_2$. The first product of the reaction is really formic acid, which then breaks down into CO_2 and hydrogen, the hydrogen being retained by the Pd. The formic acid was isolated as barium formate and identified by its reactions. It was also shown that formic acid is an intermediate product in the hot combustion of CO. A flame of CO was allowed to play upon ice; formic acid was identified in the water formed by the melting of the ice. The combustion of the hydrogen produced by the breaking-down of the formic acid furnishes the water necessary for the combustion of the CO to proceed, and at the same time prevents the reversible reaction taking place. These experiments are in agreement with Armstrong's views, and indicate that Traube's theory, according to which H_2O_2 plays an important part in combustion, is incorrect. Hydrogen peroxide occurs only as a subsidiary product formed in the first stage of the combustion of the hydrogen produced from the formic acid. It is well known that the finely-divided platinum metals catalyse the fission of formic acid into CO_2 and hydrogen. In the case of palladium-black the catalytic action is so strong that it exceeds its hydrogen-absorbing capacity, and hydrogen is evolved. Ignition of the palladium-black destroys its catalytic power, and this may account for the erroneous statement of Saint Claire-Deville and Debray that platinum-black has no catalytic effect; it is possible that they had ignited the black. The reverse action, the formation of formic

acid from CO_2 and hydrogen, is found to take place to a very slight extent under the catalytic influence of either a colloidal palladium solution or of palladium-black. T. S. P.

953. *Triferro-Carbide (Cementite), Fe_3C.* **O. Ruff** and **E. Gersten.** (Ber. Deut. Chem. Gesell. 45. pp. 68–72, 1912.)—Owing to the uncertainty as to the heat of formation of iron carbide, the authors have carried out further work on the subject. The carbide was prepared as follows: A mixture of 1000 gm. of iron (C, 4·13 %; Si, 0·074 %; S, 0·006 %; Mn, 0·15 %; P, 0·20 %; Cu, 0·005 %) with 100 gm. of powdered arc-lamp carbon was heated for 1 hour at a white heat, and the fused mass then poured on to a large iron plate. After removing oxide and dross, the cold fused mass was finely powdered and digested at the ordinary temperature with N-acetic acid for 4 weeks, and then for several weeks with N/5-hydrochloric acid. Any remaining carbon was then removed by levigation, and the residual carbide washed with alcohol and ether, and dried in a vacuum; it contained 6·69 % C and 93·28 % Fe (theory, 6·67 and 93·33 resp.). In appearance it was dark grey, and consisted, for the most part, of fragments of globular aggregates of needle-shaped crystals; it was very brittle, and could be powdered on the hand. The hardness lies between 3·2 and 3·3, so that it cannot, itself, be the cause of the hardness of rapidly cooled steel, which is probably due to the solid solution of the carbide in γ-iron; $D^{21} = 7·396$, the molecular volume being 24·34. The molecular heat of combustion, determined in a bomb calorimeter, was found to be 375·1 cals., the products of combustion being CO_2 and ferrosoferric oxide. In the actual combustions, a mixture of ferrous and ferrosoferric oxide is produced, from the analysis of which and the knowledge of the heat of combustion of ferrous oxide to magnetic oxide, the necessary correction to be applied to the observed heat of combustion of the carbide can be calculated. The molecular heat of formation of ferrosoferric oxide was found to be 265·2 cals. Pure Swedish iron (Fe, 99·745 %), and iron prepared from pure ferric chloride were used in these experiments, allowance being made for the heat of combustion of the traces of impurities present in the Swedish iron. From the molecular heats of formation of ferrosoferric oxide and of CO_2 (from graphite = 94·3 cals.), and from the molecular heat of combustion of iron carbide to ferrosoferric oxide and CO_2, the heat of formation of iron carbide (Fe_3C) is found to be − 15·1 cals.

T. S. P.

954. *Solubility of Carbon in Nickel.* **O. Ruff** and **W. Martin.** (Metallurgie, 9. pp. 143–148, Feb. 22, 1912.)—The authors have investigated the solubility of carbon in nickel between 1560° and 2500° C., by the methods described in Abstract No. 1406 (1911). Microscopic and chemical analysis show that the solubility attains a maximum of 6·42 per cent. at 2100° C., above which temperature the solubility decreases slightly. This composition corresponds to the compound Ni_3C, which appears under the microscope as a brownish material very difficult to etch. Tri-nickel carbide decomposes much more rapidly than cementite on cooling, the result being that by far the greater proportion of the carbon, even in quenched nickel alloys, occurs as graphite. The system is quite analogous to the Fe-C system.

F. C. A. H. L.

955. *Structure and Properties of Damast.* **N. T. Belaiew.** (Metallurgie, 8. pp. 699–704, Nov. 22, 1911.)—Damast is a species of steel showing a surface pattern which may become visible on polishing or not until after etching, but

is always visible to the naked eye. The macrostructure is due to irregularities in the metal, but among Orientals, damascened blades have always enjoyed the reputation of extraordinary toughness combined with hardness and elasticity, while from the modern Western point of view the best steel is that which possesses the smallest structure even under the microscope. The author has therefore sought an explanation of the good qualities of damast. In India damast is prepared by melting iron ores with carbon, and in Persia by melting iron with carbon or graphite, followed in both cases by very slow cooling in the crucible and prolonged tempering at a red heat in the absence of air. By similar means Annossow converted cast steel into "cast damast," which, however, showed a smaller pattern and did not quite attain the excellent mechanical properties of real damast, because of the lower carbon-content requisite to ensure the desired malleability. The conditions necessary for success are 8 to 9 long annealings (each of 24 hours' duration) at temperatures not exceeding dull red in the absence of air. Working under these conditions on white iron, Goerens obtained a structural equilibrium between ferrite and cementite. Further microscopic examination of a damascened blade reveals the existence of free cementite in globules grouped together in irregular veins and bunches, which give rise to the pattern. As regards mechanical properties, Lange has shown that a 0·88 per cent. carbon steel annealed long enough to produce structurally-free ferrite and cementite, possesses remarkably high toughness and ductility. Howe has observed that long-annealed steel is very malleable, and Sawin has shown that steels containing the so-called "onyx" pearlite are distinguished by extraordinary elasticity, all of which properties are inherent in the damascened blades of the Orientals. The author draws an interesting comparison between damast and modern electro-steel as regards purity of materials, the attainment of very high temperatures for prolonged periods and the possibility of exceedingly slow cooling during the process of manufacture. F. C. A. H. L.

956. *Experiments on the Efficacy of the Harmet Method of Ingot Compression.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt., Mitt. 30. 1. pp. 1–76, 1912.)—Steels with 0·21 per cent. carbon and 0·78 per cent. Mn; with 0·84 per cent. carbon and 0·78 per cent. Mn; and with 0·28 per cent. carbon, 1·78 per cent. Ni, and 0·71 per cent. Mn, were prepared in a basic open-hearth furnace. Each heat was cast into four ingots of about 8 tons, two of which were subjected to fluid compression by the Harmet process. Complete longitudinal sections were cut from the centre of a pressed and unpressed ingot from each heat, while the remaining ingots were rolled to I-girders. Samples were drilled at various points in the sliced ingots, and analysed in order to follow the effects of segregation. The complete sections were polished, etched, and examined for pipes, blow-holes, and segregated areas. Complete sections were also cut from the I-girders at various points, and subjected to polishing and etching. Mechanical tests including tensile, bending, and impact tests with notched specimens were also carried out on longitudinal and cross-sections, both in the normal state and after annealing at 850° C. The results of these very searching tests show that the compression prevents the formation of pipes which give rise to rokes after the rolling operations. These rokes are present in the top ends of all the girders, but are most numerous in the nickel steel and least numerous in the medium carbon steel. Their effect is specially noticeable in cross-sections. Generally speaking, the mechanical properties are improved by compression, apart from the prevention of rokes. F. C. A. H. L.

957. *Significance of Maximum Specific Electrical Conductivity in Chemistry.* **J. Gibson.** (Roy. Soc. Edinburgh, Trans. 48. 6. pp. 117–186, 1911.)—Attention is directed to the tendency, which is specially marked in photochemical changes, for transformations to take place in such a direction as to increase the electrical conductivity of the system. Specially simple examples are found in the action of light on selenium, and in the conversion of yellow to red phosphorus, red to black selenium, red to black mercuric sulphide. But the most interesting cases are found in systems which are capable of showing a maximum specific conductivity, *e.g.*, hydrogen chloride in water, rising to a maximum at 18·25 per cent. HCl at 18° C. The chemical changes brought about by these solutions are almost invariably such as to increase the electrical conductivity of the system, *e.g.*, HCl below 18 per cent. acts as a hydrolyst, its conductivity being increased by the removal of free water by combination with the hydrolyte; on the other hand, HCl above 18 per cent. acts as a dehydrator, its conductivity being increased by dilution with water stolen from the other ingredients of the system. Ultra-maximal hydrogen chloride (> 18 per cent.) precipitates common salt and other chlorides from their saturated solutions: premaximal hydrogen chloride (< 18 per cent.) causes more salt to dissolve. The balanced action, $2H_2O+2Cl_2 \rightleftarrows 4HCl+O_2$ tends to equilibrium at 18 per cent. HCl: weaker solutions never develop free chlorine, stronger solutions are readily oxidised when exposed to light, and the change being accompanied by an increase of electrical conductivity. Other cases considered in the same way are: The oxidation of hydrogen chloride by chromic acid, esterification, polymerisation of aldehyde, colour-change of cobalt chloride (this can actually be used to make up a 19 per cent. solution of HCl without any measurement or weighing). Cases in which other acids are concerned are: Action of hydrogen sulphide on hydrogen iodide, decolorisation being produced only in premaximal solutions; decomposition of nitric acid by light or by nitric oxide, occurring only in ultra-maximal solutions (> 29 per cent. HNO_3); charring and hydrolysis of cane-sugar by sulphuric acid; decomposition of formic acid ($H_2CO_2 \longrightarrow H_2O + CO_2$) only by ultramaximal sulphuric acid (> 80 per cent. H_2SO_4). Reference must be made to the original paper for a fascinating application of the author's theory to plant physiology, according to which the ultramaximal or premaximal nature of the sap is a determining factor in many processes. The tendency to form solutions of maximum electrical conductivity is not, however, sufficiently powerful to overcome strong chemical affinities, such as $HCl + KOH = KCl + H_2O$. T. M. L.

958. *Dependence of Conductivity of Binary Normal Electrolytes on Concentration.* **P. Hertz.** (Ann. d. Physik, 37. 1. pp. 1–28, Dec. 29, 1911.)—From a series of elaborate theoretical and mathematical considerations, a relationship is deduced between the conductivity of an ion and its concentration in a binary electrolyte. This relationship is verified in the case of the potassium, sodium, and lithium ions. The deviations in the case of lithium are perhaps only to be expected in view of the fact that no allowance is made for possible variations in the hydration, or in the linear dimensions of the ion as the concentration varies. T. M. L.

959. *Influence of Temperature on the Density and Electrical Conductivity o Aqueous Salt-solutions.* **H. Clausen.** (Ann. d. Physik, 37. 1. pp. 51–67, Dec. 29, 1911.)—The formula, $\Delta_t = A_t i + B_t(1 - i)$, connecting the density of a solution with the *i*-factor, and hence with the coefficient of ionisation

($\Delta_s = (s-1)/n$ where s = density, n = concentration) [compare Abstract No. 1042 (1910)] has been confirmed by the examination of solutions of NaCl, $NaClO_3$, $NaNO_3$, $Mg_{\frac{1}{2}}NO_3$, $Cu_{\frac{1}{2}}Cl$, $Ca_{\frac{1}{2}}NO_3$, $Br_{\frac{1}{2}}Cl$, $Ba_{\frac{1}{2}}ClO_3$, KI, KBr and HNO_3. In the case of KBr and $NaClO_3$ curves are plotted for 6°, 18°, and 80°, showing the linear relationship between Δ_s and i. T. M. L.

960. *The Effect of Salts upon the Solubility of other Salts.* V. *Solubility of Unibivalent Salts in Solutions of Salts of Different Types.* **W. D. Harkins.** VI. *Solubility of Difficultly Soluble Unibivalent Salts.* **W. D. Harkins** and **W. J. Winninghoff.** VII. *Discussion of the Solubility Relations of Unibivalent Salts.* **W. D. Harkins.** (Amer. Chem. Soc., Journ. 33. pp. 1807–1827, 1827–1836, 1836–1878, Dec., 1911.)—The solubility was determined at 25° of silver sulphate in water and in solutions of magnesium nitrate, potassium nitrate, magnesium sulphate, potassium sulphate, and silver nitrate; also of barium bromate at 25° in water and in solutions of magnesium nitrate, potassium nitrate, barium nitrate, and potassium bromate; also of lead chloride at 25° in water and in solutions of lead nitrate. The conductance of all the solutions at 25° was also measured. On plotting the solubilities of the salts as ordinates, and the equivalent concentrations of the added salts as abscissae, the solubility curves were found to belong to three types: (*a*) When a salt containing a common univalent ion is added, the solubility decreases rapidly, and the curve is qualitatively of the form to be expected from the solubility-product principle. (*b*) When a salt containing a common bivalent ion is added the change in solubility is altogether different from what would be expected from the solubility-product principle. The solubility of moderately soluble salts decreases slightly and then increases; with less soluble salts, such as barium bromate, the decrease is continuous, though slight, up to a concentration of 0·2 normal for the added salt; with extremely soluble salts the solubility increases from the beginning and the curve is of the form (*c*). (*c*) When a salt with no common ion is added the solubility always increases. The rate of increase depends upon the degrees of ionisation of the salts concerned.

VI. The solubility was determined at 25° of barium and lead iodates in water and in solutions of potassium nitrate, lead nitrate and potassium iodate. The addition to these sparingly-soluble salts of a salt with a common bivalent ion gives curves which are very nearly of the theoretical form, but the addition of a salt with a common univalent ion causes a very rapid decrease of solubility, whilst the addition of a salt with no common ion causes a rapid increase.

VII. In order to explain the observations made in the preceding papers, it is assumed that all unibivalent salts dissociate in two steps, and therefore give rise to an intermediate ion of the type KSO_4^- or $BaNO_3^+$. It is assumed that the proportion of the intermediate ion increases with the concentration, and that it has in general roughly the same value for salts of the same valence type at any given concentration. This hypothesis leads to certain deductions as to the direction and magnitude of the changes in the solubility of unibivalent salts produced by the addition of other salts with a common ion; these conclusions are in complete accord with the experimental values. Methods are suggested by which the proportion of the intermediate ion present in solutions of unibivalent salts may be approximately determined. It is shown that the solubility product $(Ag^+)^2(SO_4^{--})$ remains much more nearly constant when the presence of the intermediate ion is taken into account. T. M. L.

961. *Studies in Conductivity. I. Conductivity of Ammonia in (Anhydrous) Formic Acid. I. "Formic Acid Hydrolysis."* **H. I. Schlesinger** and **R. P. Calvert.** (Amer. Chem. Soc., Journ. 33. pp. 1924–1933, Dec., 1911.)—Solutions obtained by dissolving ammonia in (anhydrous) formic acid are excellent conductors. The substance formed in these solutions (ammonium formate), although a very highly ionised electrolyte, obeys the law of mass action in the more concentrated solutions. In accordance with the conception that the salts of the halogens are, in formic acid solution, really the salts of strong bases (the formates) and of weak acids, the view is adopted that potassium chloride, bromide and iodide and sodium and ammonium chlorides are decomposed by "formic acid hydrolysis." T. M. L.

962. *Viscometric Determination of Transition Points.* **A. E. Dunstan** and **H. Langton.** (Chem. Soc., Journ. 101. pp. 418–423, March, 1912.)—Curves are plotted for the viscosity at different temperatures of saturated solutions of a series of simple and double salts. The transition temperatures are indicated by breaks in the viscosity curves as follows :—

Astrakanite	$NaSO_4, MgSO_4, 4H_2O$	21·7°
Sodium sulphate	$(10 \rightleftarrows 0H_2O)$	32·6° (32·4°)
Sodium carbonate	$(10 \rightleftarrows 7H_2O)$	32·5° (31·85°)
„ „	$(7 \rightleftarrows 5H_2O)$	35·4° (35·1°)
Sodium bromide	$(2 \rightleftarrows 0H_2O)$	50·5° (50·7°)
Barium acetate	$(3 \rightleftarrows 1H_2O)$	25·2° (24·7°)
„ „	$(1 \rightleftarrows 0H_2O)$	42·2° (41°)

The figures given in brackets are the transition temperatures as determined by other methods. T. M. L.

963. *Electric Osmose and Concentration of the Electrolyte.* **J. O. W. Barratt** and **A. B. Harris.** (Zeitschr. Elektrochem. 18. pp. 221–225, April 1, 1912.)—Measurements were made of the electric osmose through membranes of parchment-paper, gelatine, and agar-jelly in the case of aqueous solutions of Na_2SO_4, $NaOH$, $NaNO_3$, HNO_3, $Cu(NO_3)_2$, $Al(NO_3)_3$, Na_3PO_4, $NaOH$, $NaCl$, HCl, $CuCl_2$, and $AlCl_3$. Usually the flow was found to increase according to a linear law as the concentration increased, but the agar jellies, although normal with sodium nitrate solutions, gave maximum values at a concentration of about 0·01 mol. per litre in the case of the other salts. Maxima were also given by copper chloride and aluminium chloride with a parchment membrane. The gelatine membranes were remarkable in that the flow was from anode to kathode for $NaNO_3$, $NaOH$, $NaSO_4$, but from kathode to anode in HNO_3, $Cu(NO_3)_2$, and $Al(NO_3)_3$; in the other membranes the flow was always from anode to kathode. T. M. L.

964. *Free Energy of Dilution of Hydrochloric Acid.* **R. C. Tolman** and **A. L. Ferguson.** (Amer. Chem. Soc., Journ. 34. pp. 232–246, March, 1912.)—It has usually been assumed that the ions move with the same velocity under unit potential gradient in solutions of all different concentrations. The validity of this assumption was denied by Jahn, who explained his results by assuming increased speed with increased concentration. The proportionality between "fugacity" and concentration has been verified over wide ranges of concentration both for weak and for strong electrolytes, but the authors find from observations made with "concentration-cells without transference" that marked discrepancies occur in the case of hydrogen chloride. These lead them to view with suspicion the ordinary methods of calculating ionic concentration from conductivity measurements, and they propose to employ a method of calculation based upon conductivity and transference data without assuming that the ions move with the same velocity at different dilutions. T. M. L.

965. *Mechanism of the Semi-permeable Membrane and a New Method of determining Osmotic Pressure.* **F. T. Trouton.** (Roy. Soc., Proc. Ser. A. 86. pp. 149–154, Jan. 31, 1912.)—The pressure required to make ether take up from a solution containing 600 gm. of sugar per litre as much water as it would from the pure liquid at atmospheric pressure, is 79 atmos. It is maintained that this represents the osmotic pressure of the solution. The value obtained experimentally by Berkeley and Hartley was 81 atmos. T. M. L.

966. *Chemical Transformations in Compressed Gaseous Systems.* **E. Briner** and **A. Wroczynski.** (Archives des Sciences, 32. pp. 389–414, Nov., 1911.)—In a number of cases extreme compression is found to bring about chemical changes which invalidate completely all attempts to measure critical constants, &c. Thus nitric oxide, condensed by liquid air into tubes which were sealed and allowed to return to atmospheric temperatures, gradually decomposed with formation of greenish-blue drops of nitrous anhydride; this effect can be developed in 12 hours under 280 atmos. pressure—

$$2NO = N_2 + O_2 ; \ 4NO + O_2 = 2N_2O_3.$$

Nitrous oxide, on the other hand, does not decompose under these conditions. Carbon monoxide at 320° under 400 atmos. showed a marked decomposition in 12 hours; 20 hours at 600 atmos. gave a contraction of 10 per cent.: $2CO = C + CO_2$. The decomposition of cyanogen and acetylene is favoured by compression at 220°, but methane is not affected at ordinary temperatures. T. M. L.

967. *Component Values of the E.M.F. of a Voltaic Cell.* **G. Guglielmo.** (Accad. Lincei, Atti, 21. pp. 102–109, Jan. 21, 1912.)—The author proves theoretically the admissibility, in calculating the component values of the e.m.f. of a voltaic cell, of adopting the formula, $V = (C - c)/e$, where V is p.d. between the metal and electrolyte, C the heat absorbed or produced by solution of a certain quantity of metal, and c the corresponding local heating (Peltier-effect), both expressed in joules, and e the corresponding quantity of electricity, in coulombs, which passes from the metal to the electrolyte or *vice versâ* [see Abstract No. 425 (1911)]. W. H. Si.

968. *An Electric Light Accumulator.* **C. Winther.** (Zeitschr. Elektrochem. 18. pp. 138–143, Feb. 15, 1912.)—The spontaneous oxidation of aqueous ferrosalt is accelerated by ultra-violet light, and in the presence of mercuric chloride the reaction $Fe^{\cdot\cdot} + Hg^{\cdot\cdot} + \text{light} = Fe^{\cdot\cdot\cdot} + Hg^{\cdot}$ takes place. This reaction is nearly independent of the temperature and reversible, but the counter reaction is very slow at ordinary temperature, so that light energy is stored up; when current is taken from the system, however, the counter reaction is accelerated. A Pt-foil is fixed horizontally in a funnel and covered with platinised asbestos, over which the solutions ($FeCl_2$, $HgCl_2$) are poured; a Pt-wire penetrates into the foil through the funnel, and for potential measurements, &c., another Pt-foil is dipped into the solutions. The funnel is placed immediately under a quartz mercury lamp. H. B.

969. *Potential of the Potassium Electrode.* **G. N. Lewis and F. G. Keyes.** (Amer. Chem. Soc., Journ. 34. pp. 119–122, Feb., 1912.)—The potential of potassium in a normal solution of potassium ion at 25° is found to be 3·2084 volts against the normal calomel electrode taken as zero. This is the sum of two values: (1) 2·1603 volts, the potential of 0·2216 per cent. potassium amalgam against normal potassium ion, and (2) 1·0481 volts, the difference in potential between potassium and 0.2216 per cent. potassium amalgam in a solution of potassium iodide in ethylamine. The temperature-coefficient of the latter e.m.f. is —0·000272 volt per deg.; hence the heat of solution of potassium in mercury is 26,050 cals. T. M. L.

970. *Anodic Behaviour of Uranium.* **U. Sborgi.** (Accad. Lincei, Atti, 21. pp. 135–140, Jan. 21, 1912.)—Experiments on the electrolytic solution of uranium in H_2SO_4 + sulphate, HNO_3 + nitrate, HCl + chloride, bromide, iodide, acetate, and chlorate, show that the metal dissolves according to the valency 4. The U employed contained varying amounts of carbon, which is assumed to have no effect on its electrolytic properties, but when the proportion of carbon is high, a considerable quantity of CO_2 is developed, and the amount of U dissolved is then much reduced, the difference being approximately equal to the U which would correspond to the CO_2 produced. In phosphates and alkalies the electrode becomes covered with a yellow film, and the current falls to a minimum. In NaOH the U dissolved in some cases corresponded to U'''', but in others was much less. It is concluded that U does not assume a passive condition—a view which the author has confirmed by experiments on the anodic polarisation in nitrate, sulphate, and chloride. W. H. Si.

971. *Passivity in Mixtures of Ferro- and Ferripotassium Cyanides.* **G. Grube.** (Zeitschr. Elektrochem. 18. pp. 189–211, March 15, 1912.)—In the course of an investigation on the electrolytic preparation of ferripotassium cyanide the author made observations on the suitability and passivity of anodes of different metals in neutral or alkaline mixtures of ferro- and ferripotassium cyanides. His electrodes were foils of 2·5 by 4 cm.; the kathodes consisted of Ni or Pt. Anodes of Pt, Au, Ni, Co, Cu could not be polarised in alkaline solution, and the oxidation of the ferrous compound hence appears to be instantaneous. Anodes of Fe, Ni, Co, Cu, Pb, Ag are polarisable in alkaline mixtures, some also in neutral mixtures. The polarisation is due to a protective surface layer of oxide, which need not be visible (not in iron); the peroxides of the metals appear to act as oxygen carriers [analyses are not mentioned]. Sometimes there is merely an oxygen film apparently, since the oxidation may take place at the same rate with anodes of Au, Pt, Ni, Cr, Cu. H. B.

972. *Some New Features in the Electrolytic Determination of Lead.* **J. G. Fairchild.** (Industrial and Engin. Chemistry, Journ. 3. No. 12. Chem. News, 105. pp. 219–220, May 10, 1912.)—Good and quantitative deposits of lead dioxide, free from flakes and of close texture, can be obtained on a smooth Pt cylinder in 2 hours' time without rotation. The weight of the deposit may be as much as 100–200 mgm.; if it is raised to 300 mgm. there is danger of flaking off. The secret of success is a low amperage to begin with, and a hot solution, 50–60° C. The solution electrolysed should contain about 0·1 gm. of metallic lead and have a volume of 200 c.cm. after the addition of 30 c.cm. of concentrated nitric acid. The anode should have an area of about 25 sq. in., the kathode of 12 sq. in.; the former should be burnished frequently and ignited previous to placing in the electrolyte. The current is maintained at 0·25 amp. for 1½ hours and then raised to 0·5 amp. for half an hour longer to deposit the last traces of lead. After washing with water the anode is rinsed with alcohol, drawn through a flame to burn off the adhering alcohol, dried by holding for a few seconds about a foot above the flame, cooled and weighed. Details are given for the determination of lead in lead scrap, furnace dross, blister copper, and copper matte. When the lead is obtained as lead sulphate in the preliminary operations it is necessary only to dissolve it in ammonium acetate before adding the nitric acid for electrolysis. T. S. P.

973. *Part played by Interatomic Electrons in Electrolysis.* **P. Achalme.** (Comptes Rendus, 154. pp. 647–649, March 4, 1912.)—Chemical reactions result from the addition or withdrawal of electrons from the system. In many cases, as in electrolysis, the total number of interatomic electrons remains unchanged, but their distribution is altered. This is explained with reference to the decomposition of water, of acids (sulphuric acid), bases and salts, and to the ionisation of gases. In the latter case, when a gas molecule is displaced by a shock or electromagnetic disturbance (α-, β-rays, kathode rays, light), the electrons accompany the one fragment and charge it negatively, while the other assumes a positive charge. Thus there arise in hydrogen $\overset{+}{\mathrm{H}}$ and $\overset{-}{\mathrm{H}}e$, and in chlorine $\overset{+}{\mathrm{Cl}}$ and $\overset{-}{\mathrm{Cl}}e$. H. B.

974. *Formation of Badly Conducting Layers by the Electrolysis of Glass.* **G. Schulze.** (Ann. d. Physik, 37. 3. pp. 435–471, March 8, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Test-tubes of Thuringia glass were electrolysed at 350°, using different anodes, and the changes taking place determined by weighing the tubes before and after electrolysis. The particular anode used (molten metal, powdered metal, or molten salt) was contained in the test-tube itself, the current connection being made by means of an immersed arc carbon or by Pt wire; the test-tube dipped into the katholyte, which consisted of a mixture of sodium and potassium nitrates, the kathode being iron wire. Graphite and Pt form insoluble anodes, oxygen being anodically evolved from the glass. Mercury migrates quantitatively, as the divalent ion, into the glass. Cd, Bi, Pb, Sn, Fe, and Cu migrate quantitatively into the glass only when the surface is free from oxides. Anodes of metallic oxides are insoluble. The resistance of the glass is diminished by the migration into it of lithium or silver, increased by K, Tl, Cu, or Fe, and very considerably increased by Cd, Hg, Pb, Bi, or Sn. In the case of the introduction of the last-named metals into the glass, as also of the formation of layers when insoluble anodes are used, the resistance increases very much with decrease in current strength. The resistance of the layers formed by K and Na is independent of the current strength. The effect of temperature on the resistance of the badly conducting layers is much less than on the unaltered glass. With an alternating current of 50 ∿ it was not possible to use a glass cell as a rectifier. If the metals Hg, Cd, Bi, Pb, Sn have been introduced into the glass from the anode side, reversal of the current leads only to a very small migration back to the anode, assuming that the metal anode is replaced by an electrolyte before the reversal of the current. If it is not so replaced the badly conducting layer at the moment of reversal is pierced by numerous small sparks and the metal remains in the glass. The dynamic characteristics of the badly conducting layers were measured with a pulsating direct current, using Simon's method, and hence the capacities found. The thickness of the layers was calculated from the known alkali-content of the glass and the quantity of electricity used in forming them, and, knowing the capacity, the dielectric constant was calculated; the results are given for C, Hg, Sn, Pb, Bi, and Cd anodes. The reason that glass cells cannot be used as rectifiers is that the badly conducting layers in the glass are solid layers, in which ordinary electrolytic processes are taking place, whereas in electrolytic rectifiers the active layers consist of gases. T. S. P.

975. *Electrolysis of Impure Coppers in a Sulphate Electrolyte.* **E. Vuignier.** (Houille Blanche, 11. p. 48, Feb., 1912.)—In the electrolytic refining of copper, difficulties are encountered owing to the presence of arsenic and antimony in the crude copper. According to the author a continuous, satisfactory deposition of copper can be maintained over an indefinite period by the addition of anhydrous sodium sulphate to the electrolyte from time to time. Hydrated sodium sulphate cannot be used, and the author offers an explanation of the different actions of the anhydrous and hydrated salts. The following are the particulars of the process as adopted at Eguilles: The electrolyte is a 15 per cent. solution of copper sulphate, containing 5·5 per cent. of free acid. The current density at the electrodes, which are 50 mm. apart, is 75 amps. per sq. m., the voltage being 0·85 volt. The temperature of the bath is 87° C., and the electrolyte is circulated at the rate of 800 litres per hour. Once a fortnight, 6 kg. of anhydrous sodium sulphate are added for every cub. m. of electrolyte. From time to time the excess of sodium sulphate is removed by allowing the decahydrate to crystallise from the electrolyte at ordinary temperatures; the acidity of the bath must also be corrected at intervals. T. S. P.

976. *Viscosity of Colloidal Metal Solutions.* **V. Mifka.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1178–1185, July, 1911.)—The viscosity of colloidal solutions of metals does not differ appreciably from that of pure water. T. M. L.

977. *The Theory of Solubility.* **D. Tyrer.** (Journ. Phys. Chem. 16. pp. 69–85, Jan., 1912.)—It is suggested that the concentration of the solvent is an important factor in determining solubility, which could thus be increased by compressing the solvent. T. M. L.

978. *Variability of the Quantity* b *in van der Waals' Equation of State, also in connection with the Critical Quantities.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 278–297, Oct. 26; 428–442, Nov. 22, 1911; 563–579, Jan. 24, and pp. 711–728, Feb. 22, 1912.)—Theoretical.

979. *On Volume Correction of the Equation of State for Gases.* **J. Nabl.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 851–888, June, 1911.)—A highly mathematical paper.

980. *The Law of Transformation Stages.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 788–801, Feb. 22, 1912.)—A theoretical consideration.

981. *Surface Effects between Mercury and Certain Solutions and an Electrochemical Method of estimating dissolved Oxygen.* **S. W. J. Smith and W. F. Higgins.** (Faraday Soc., Trans. 7. pp. 64–77; Discussion, p. 77, Nov., 1911.)